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4

DIODE INSPECTION PROCESS

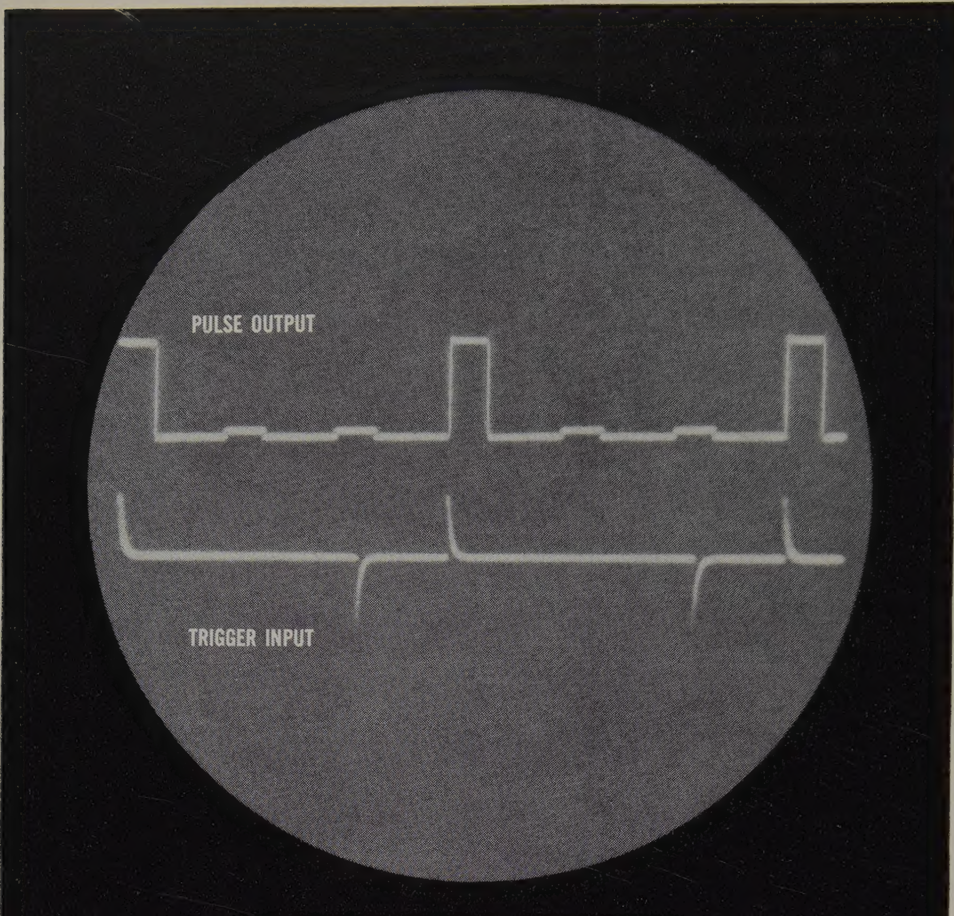
Transistorized TV and FM Tuners

Transistor Capacitor Shift Register

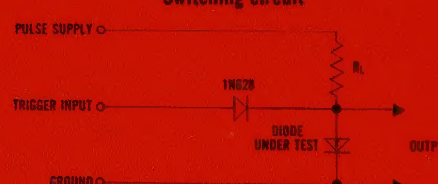
Transistorized TV Transmitting Equipment

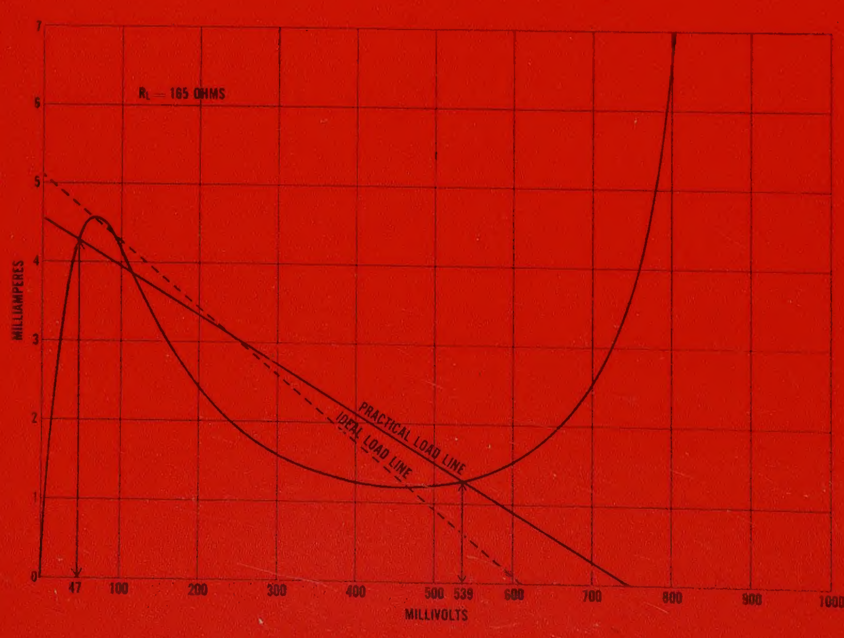
Temperature Dependence of Ge and Si Characteristics

Hoffman design-aid series

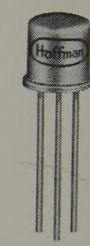


Input and output wave forms for circuit shown below





Practical load line indicates operation with optimum stability



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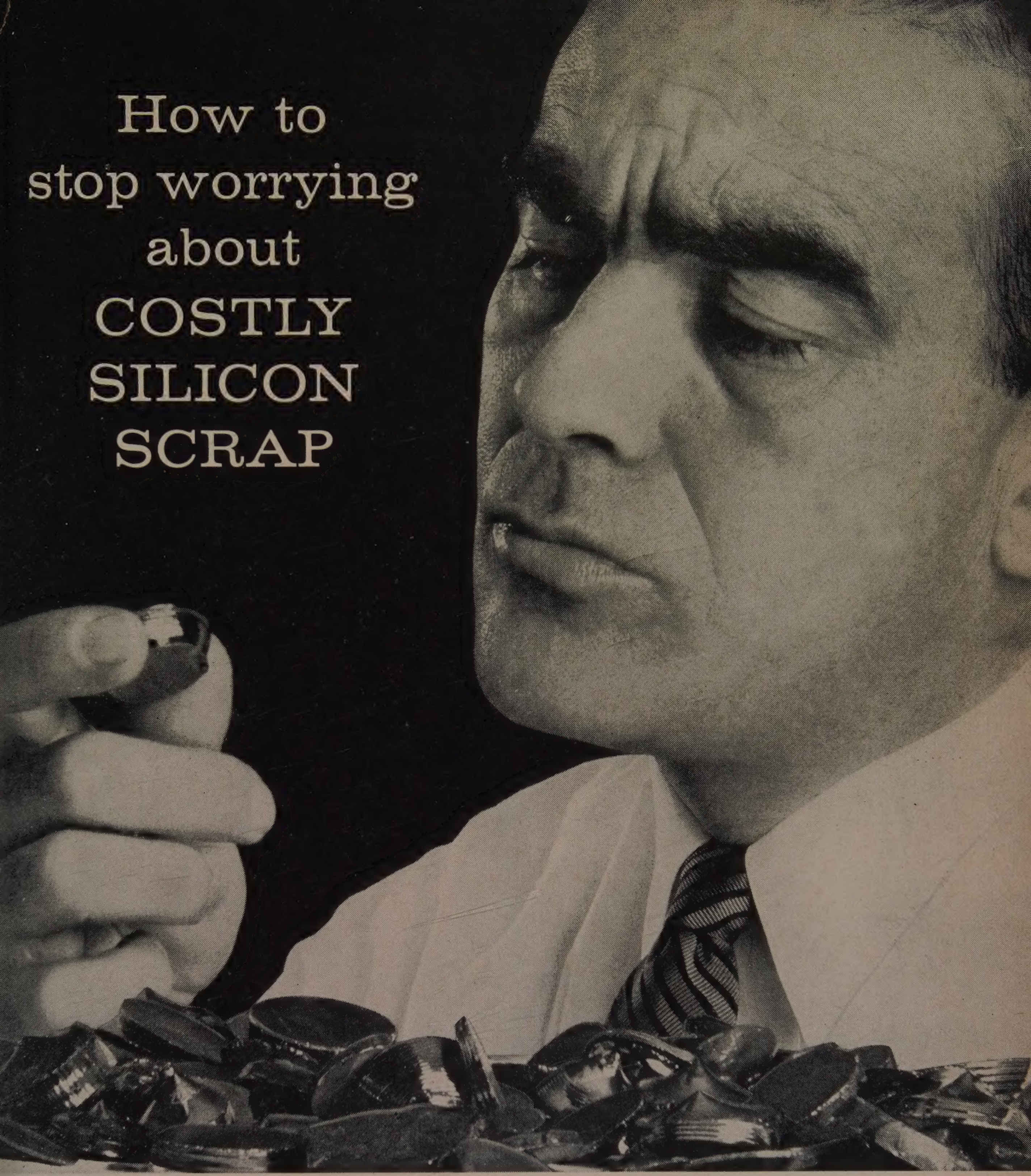

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SEMICONDUCTOR PRODUCTS

SANFORD R. COWAN, Publisher

July 1960 Vol. 3 No. 7

CONTENTS

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Front Cover

Tunnel Diode image appearing on round glass screen of the Jones & Lamson Machine Company's optical inspection comparator. A new normal reflection unit was used as the source of light. A slotted parabolic reflector concentrates high intensity light on a tiny area for high magnification. Points of inspection of the tunnel diode are: quality of seal, joining of the lead wire to the bead, gold contact to wafer, surface condition of wafer, extent of doping on the cat's whisker, flaking or other foreign material, and point of cat's whisker.

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MAXIMUM RATINGS (25°C)—(Note 1)

WIV	Working Inverse Voltage	150 V
I_0	Average Rectified Current	100 mA
I_F	Forward Current Steady State D.C.	150 mA
i_f	Recurrent Peak Forward Current	300 mA
i_f (surge)	Peak Forward Surge Current Pulse Width of 1 sec.	500 mA
i_f (surge)	Peak Forward Surge Current Pulse Width of 1 μsec.	2000 mA
P	Power Dissipation	250 mW
P	Power Dissipation	100 mW @ 125°C
T_A	Operating Temperature	—65° to +175°C
T_{stg}	Storage Temperature, ambient	—65° to +200°C

ELECTRICAL SPECIFICATIONS (25°C unless noted)

SYMBOL	CHARACTERISTICS	MIN.	TYPICAL	MAX.	TEST CONDITIONS
V_F	Forward Voltage	--		1.0 V	$I_F = 100$ mA
I_R	Reverse Current			0.1 μA	$V_R = -150$ V
I_R	Reverse Current (150°C)			100 μA	$V_R = -150$ V
BV	Breakdown Voltage	200 V			$I_R = 100$ μA
t_{rr} (Note 2)	Reverse Recovery Time			50 mμsec	$I_f = 30$ mA $I_r = 30$ mA $R_L = 150$ Ohms
C_0 (Note 3)	Capacitance			5.0 μμf	$V_R = 0$ V f = 1 mc
RE (Note 4)	Rectification Efficiency	35%			f = 100 mc
	Forward Voltage Temperature Coefficient		—1.8 mV/°C		

NOTES:

(1) Maximum ratings are limiting values above which life or satisfactory performance may be impaired.

(2) Recovery to 1.0 mA.

(3) Capacitance as measured on Boonton Electronic Corporation Model No. 75A-S8 Capacitance Bridge or equivalent.

(4) Rectification Efficiency is defined as the ratio of D.C. load voltage to peak rf input voltage to the detector circuit, measured with 2.0 V r.m.s. input to the circuit. Load resistance 5 K ohms, load capacitance 20 μμf.

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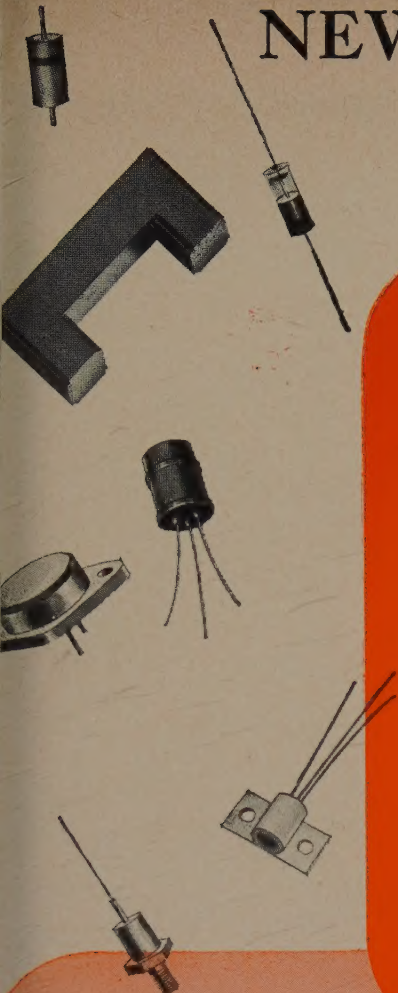

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2N1118A	Amplifier, Switch, Control	f_{max}-8 mc	high beta version 2N1118
2N1119	Switch	f_T-7.2 mc	electrical equivalent of 2N496, TO-5 case
2N1428	Amplifier, Switch, Control	f_{max}-18 mc	low cost, high beta, TO-1 case
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2N1271	High Frequency Amplifier	f_{max}-125 mc	medium beta
2N1272	High Frequency Amplifier	f_{max}-125 mc	high beta
2N1472	Switch	f_T-75 mc	very low V saturation superior temperature stability
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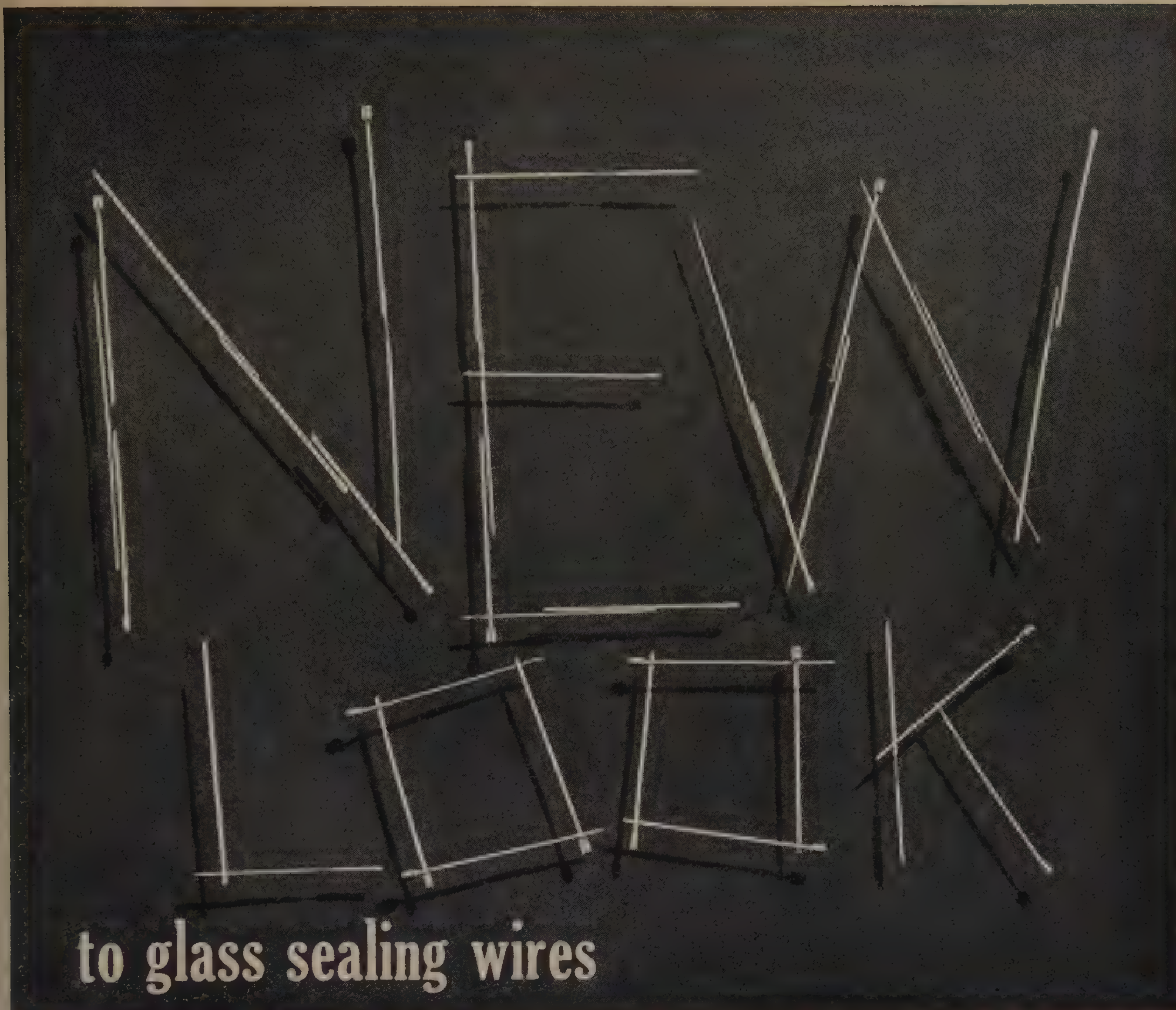

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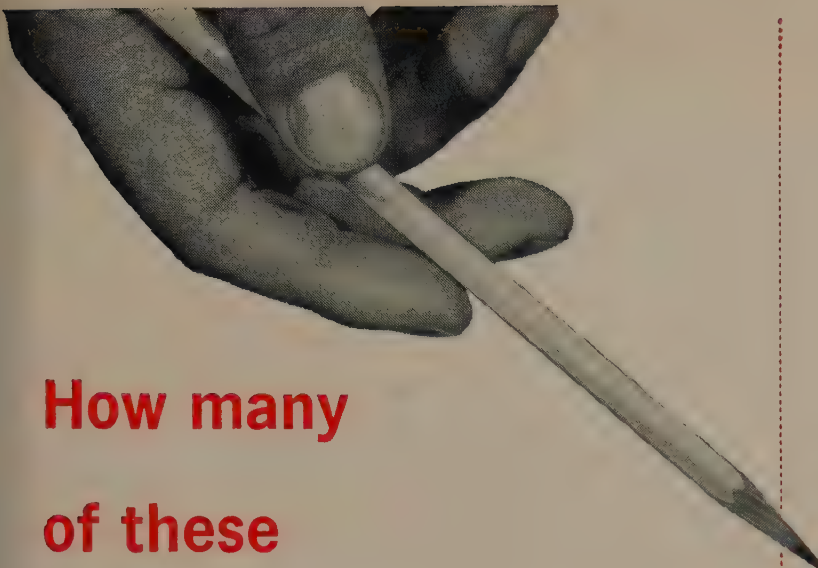

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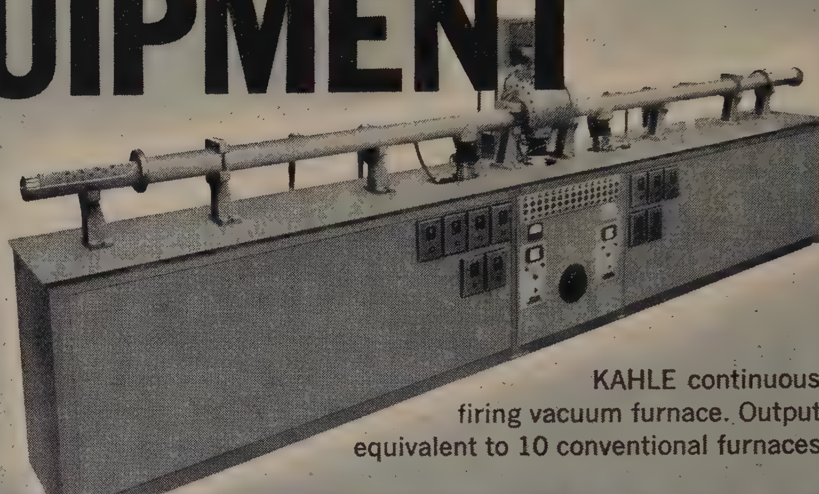

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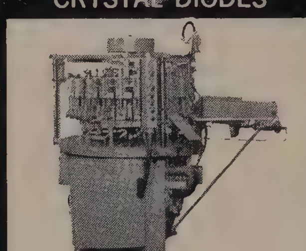

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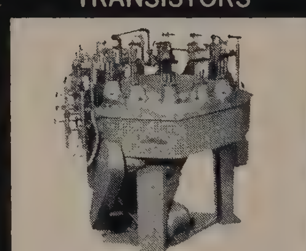

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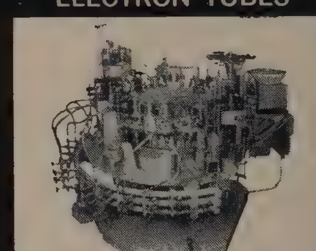

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Editorial . . .

Progress In Solid State Devices

Since the discovery of the tunnel diode no new devices have appeared of comparable technical importance. Researchers everywhere seem to concentrate on finding ways for understanding and improving the state of art. Major areas of investigation are: the application of compound semiconductors for the construction of tunnel diodes and transistors, the construction of multijunction devices of novel geometry, the study of the properties of optoelectronics and thermoelectric devices.

Significant advances in these fields were announced at the recent IRE-AIEE Solid State Devices Conference. For instance the construction and the properties of tunnel diodes derived from heterogenous junctions (two semiconductors of different energy gaps, such as germanium and gallium arsenide) were discussed. In addition, the characteristics of tunnel diodes obtained with indium arsenide, gallium arsenide and alloys of indium arsenide with indium phosphide were presented.

The gain bandwidth product of tunnel diode amplifiers is inversely proportional to the product of the negative resistance and the junction capacitance. To make the latter small one reduces the size of the junction surface, but this is limited by the fact that at a certain point the absolute value of the negative resistance increases. To obtain a lower junction capacitance it is necessary to use semiconductors with larger energy gap. With gallium arsenide, diodes having cutoff frequencies up to 2 *kmc* and peak-to valley ratios up to 70 to 1 have been obtained.

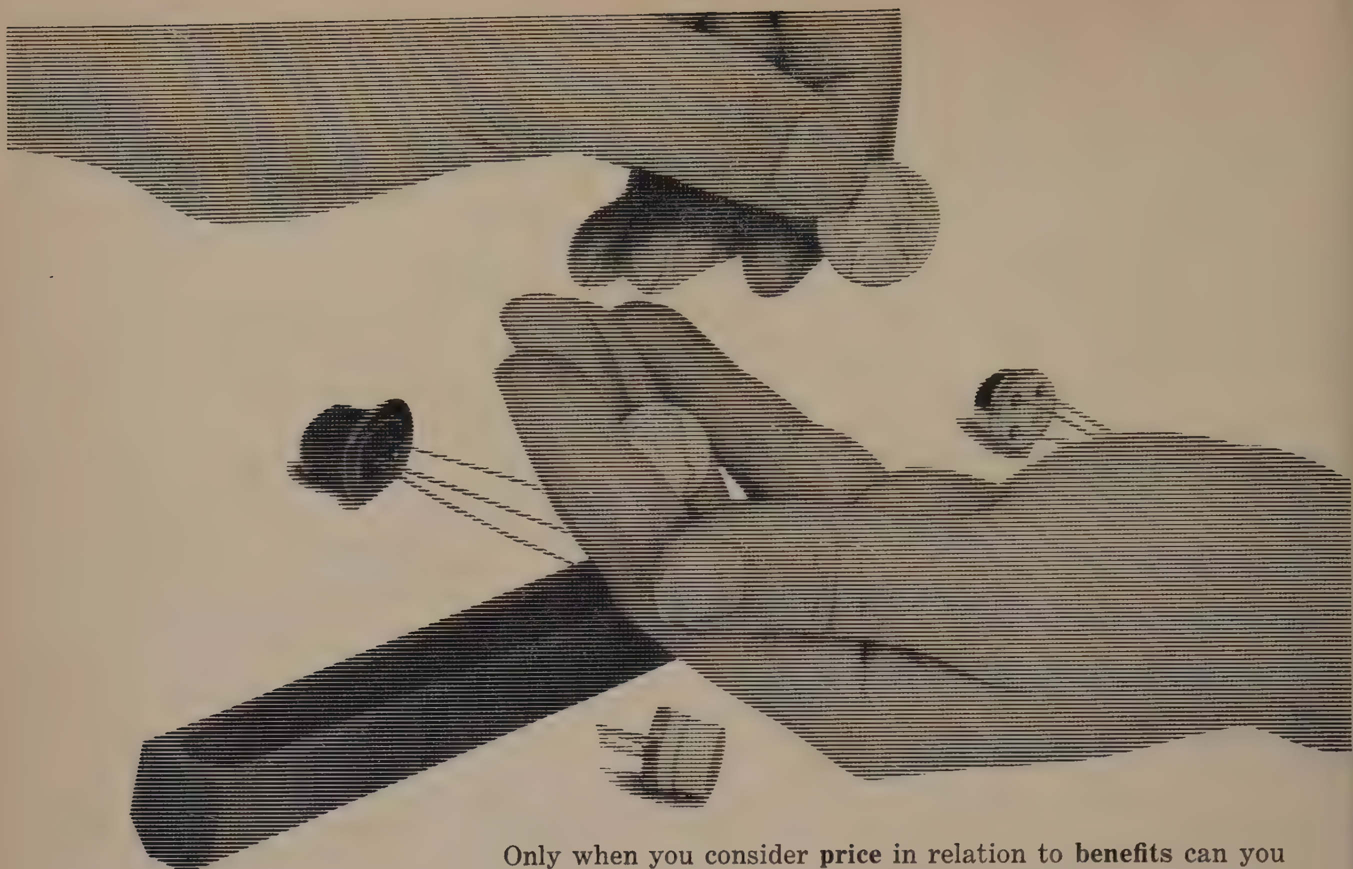
An improvement in the collector saturation resistance and storage time of mesa type transistors has been obtained by means of a simple modification of the collector. This consists of depositing a lightly doped film on a heavily doped semiconductor and making the film act as the actual collector on which the remaining mesa structure is built. The resulting structure presents higher breakdown voltage, lower collector capacitance, lower turn-off time, and even improved temperature stability.

Several new geometries of multijunction devices were proposed. For instance, a device with two junctions on the same side of a wafer and a third junction on the other side may be used as an amplifier with voltage controlled transconductance, or as a voltage regulator. A device with four separate junctions, three in cascade, as in a transistor triode, and the other two on the same terminal region, presents characteristics of a gate-controlled rectifier of high sensitivity and low temperature dependence. Finally a cascade combination of four junctions may be used as a *p-n-p-n* multivibrator whose load resistance is the reverse resistance of a diode. Such a device has good temperature stability and may be used as a relaxation oscillator whose frequency is linearly related to the illumination.

The technique of construction of transistors with compound semiconductors can stand a great deal of improvement. Gallium arsenide transistors possess rather low alphas, but present matched gains of the order of 30 db and alpha-f_{co} products of the order of 100 mc. Higher alpha values are obtainable using indium arsenide semiconductors.

An interesting phenomenon of relaxation oscillations similar to that found in gaseous plasmas contained by means of a magnetic field has been discovered recently by Rivkin. If a *d-c* current is passed through a semiconductor placed in a strong magnetic field parallel to the current, relaxation oscillation of various frequencies may be obtained.

Samuel L. Marshall



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Transistorized TV and FM Tuners

KARL WITTIG*

This article describes some of the design considerations for *vhf* front ends, using *madt* and *mesa* transistors as *rf* amplifiers, mixers and oscillators. Both common emitter and common base configurations are compared as to their characteristics and suitability. Practical applications are explained by means of Standard Coil TV and *fm* tuner schematics. Input and interstage matching are discussed together with *agc* methods and their effect on bandpass characteristics.

SINCE THE ORIGINAL INVENTION of the transistor by J. Bardeen and W. H. Brattain in 1948, continuous development has advanced the art toward higher and higher frequencies. In the *vhf* frequency region there has been a steady improvement in gain and a steady reduction in noise figure. Recently satisfactory *vhf* transistors have become available at reasonable prices and communications engineers are now called upon to redesign conventional communications circuitry around such transistors. *FM* and TV tuners, *if* and video amplifiers, mobile receivers and transmitters have to be developed to satisfy the every increasing demand for smaller and lighter units that will give satisfactory operation with a minimum of power consumption. All of this must be achieved without any appreciable reduction in the performance standards. This article will discuss the *fm* and TV tuner area. It will review the requirements that the communications engineer is faced with in this new area. It will discuss some complete designs of equipment satisfying these requirements.

Noise Figure

Noise figure is of major importance in tuner design and particularly in the design of the *rf* amplifier, for it is the *rf* amplifier which normally determines the overall signal-to-noise ratio of the receiver. A noise figure of 5-6 *db* at channels 2 through 6 and 7-8.5 *db* for channels 7 through 13 can be achieved at the present state of the art. This is by no means the ultimate and further improvements can be expected. For *fm* tuners the noise performance is normally described by a quieting sensitivity measurement. Similar noise figures to those quoted for the TV tuner may be expected.

Gain

Since the transistor is basically a power amplifier it is most convenient to express stage gain in terms of power gain. The power gain in *db* is given by

$$P.\,G. = 10 \log_{10} \frac{P_2}{P_1}, \tag{1}$$

where P_1 is the input power and P_2 is the output power. If the input and load impedances are equal then the same gain may be expressed as a voltage gain

$$V.\,G. = P.\,G. = 20 \log_{10} \frac{E_2}{E_1}, \tag{2}$$

where E_1 is the input voltage and E_2 is the output voltage. In the case where there are unequal input and load impedances, the power gain may be calculated from

$$P.\,G. = 20 \log_{10} \frac{E_2\sqrt{Z_1}}{E_1\sqrt{Z_2}}, \tag{3}$$

where Z_1 represents the input impedance and Z_2 the load impedance.

An overall power gain of 35-40 *db* may be expected in a TV tuner for Channels 2 through 6 and 22-27 *db* for Channels 7 through 13. These figures were obtained in a prototype tuner designed by Standard Coil Products around the Texas Instrument transistor series, *R307*, *R308*, and *R309*. Other transistor types are under investigation. Similar power gains may be expected in an *fm* tuner.

Bandwidth

A TV tuner requires an overall bandwidth of 4.5 *mc*, measured at the 3 *db* response points. FM tuner design required an overall bandwidth of 200 *kc* to 500 *kc* depending upon the particular end use. Whenever possible, double tuned transformer coupling should be employed in the RF stages to get good channel selectivity.

Input and Output Impedance

FM and TV tuners are usually designed to operate

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from a 75 ohm unbalanced or a 300 ohm balanced source impedance. For 300 ohm balanced source, a balun transformer is generally used to convert the source to a 75 ohm unbalanced impedance and is then fed directly into the input matching network. For 75 ohm source impedances, the signal is fed directly to the input matching network.

The *if* output of the tuner should be fed into a load simulating the input impedance of the following *if* stage. A typical value would be a 50 ohm resistive load shunted by a 22 $\mu\mu f$ capactitor.

Automatic Frequency Control

The transistor is a temperature sensitive device and it is necessary to make provision to prevent oscillator drift. For transistorized *fm* tuners, an *afc* circuit should be considered, regardless of any other means of oscillator stabilization such as the use of negative temperature coefficient capacitors, emitter resistors, thermistors, etc. It has been found at Standard Coil that the most acceptable automatic frequency control is achieved with the use of a reverse biased silicon diode operating as a voltage variable capacitor. The diode is coupled through a small capacitor (approximately 5 $\mu\mu f$) to the oscillator tuned circuit. In order to achieve approximately symmetrical frequency correction for both positive and negative *afc* voltage, a fixed bias of about 3 *v* should be applied to the diode. The *afc* correction voltage, which may originate either from a discriminator or a ratio detector, is applied to the diode to vary its capacity.

Automatic frequency control may also be considered for a TV tuner but it is generally unnecessary with a well compensated oscillator circuit.

Automatic Gain Control

A simple method for reducing the signal level in a TV tuner would involve the insertion of an attenuation pad into the antenna input circuit. This would, of course, have to be manually adjusted. Such a method has received some consideration because of some of the difficulties of applying *agc* to a transistorized tuner. It is not as easy to achieve good *agc* performance in a transistorized tuner as it is in a conventional tube tuner. The cause of the difficulty lies in the input and output characteristics of the transistor. As we shall see in a moment, we may reduce the gain of a transistorized *rf* stage either by reducing the collector current or by reducing the collector voltage. In either case, the associated change in the input and output impedance of the transistor will have an effect on the associated resonant circuits. To reduce the effect of the capacity change, one has the choice of either swamping the input and output with a large capacity or making the input circuit as broad as possible in order to eliminate having the response curve "tilt with the bias." This tilting may wash out the fine detail of a TV picture and may also cause intercarrier buzz because of the changing relationship of the amplitude of the picture and sound carrier.

There are two methods of achieving automatic gain control in a transistorized *rf* amplifier. The first of these is *forward agc* wherein a resistor (approximately 2.2 K) is placed in series with the collector lead such that the collector voltage will drop as the collector current is increased. An increase in the base bias (forward bias) will result in an increase in the collector current, a decrease in the collector voltage, and a decrease in the gain of the stage. The disadvantage of this method is that a rather large supply voltage is needed to overcome the voltage drop across the series resistor at the maximum gain operating point. An advantage is the relatively smaller change of input impedance with applied *agc* voltage. The second scheme is *negative agc* wherein the collector current is reduced by reducing the base bias. It is the bias voltage change which accompanies this *agc* action which may lead to "tilt with bias." When using negative *agc,* care must be taken not to deteriorate the *vswr* at the input. In some cases the input capacity may be tuned out using inductance and, since the parallel resistance is small, a wide input bandwidth will result. In the tuner to be described in this article, which uses negative *agc,* this problem has been solved by using a series tuned input network. The circuit is first adjusted for match and then the "tilt with bias" coil, in the *rf* input circuit, is tuned to resonate with the input capacity at the lower channels when the *agc* is such that the *rf* gain is at a minimum. This circuit helps to provide excellent "tilt with bias" characteristics. A similar circuit has been successfully used for a TV tuner using forward *agc*.

It is important that no deterioration in *vswr* occurs when *agc* is applied because of the effect of *vswr* on the noise figure. In the tuner to be described the input network is so designed that the match improves initially as *agc* is applied. Only in the low gain region does the match become such that the noise figure increases significantly.

It is most important that the tuner alone not be relied on to provide all of the dynamic gain control range. The *if* amplifier stages should be fully utilized for this purpose.

Other Requirements

In addition to the major requirements detailed above, other specifications such as cross modulation, *if* rejection, overload, image rejection, oscillator drift, etc., must also be considered.

Design Considerations

Let us now consider the properties of some of the available *vhf* transistors. The circuit designer has the option of considering common base or common emitter operation. Each of these configurations have certain merits and certain disadvantages. Let us first consider a typical *rf* amplifier using a common base

configuration. See *Fig. 1*. One of the interesting properties of the Philco *madt* type transistor is its input resistance characteristic which is shown in *Fig. 2*. The common base input resistance increases from 25 ohms at channel 2 to about 38 ohms at channel 6. Between channel 7 and 13 it increases from 103-135 ohms. This indicates that a 5:1 impedance change takes place between channels 2 and 13. The output resistance of the Philco T1694 is shown in *Fig. 3*. There is a reduction from 8 *K* at Channel 2 to 6 *K* at channel 6 and a reduction from 4.5 *K* at Channel 7 to 4 *K* at channel 13. These impedance changes must be compensated for in the design of the interstage network. It should be further added that the reactive portion of the input and output impedance, which can appear negative or positive, is also a function of frequency. Both the resistive and reactive components of the input and output impedances are also functions of the operating point. The variability of the input and output impedance with bias point and frequency is also experienced in the common emitter connection. The common base circuit has a tendency to become regenerative since the emitter and collector voltages are close to being in phase. The insertion of a small external capacity between collector and emitter can cause the *rf* amplifier to become an oscillator. This regeneration can be controlled to some degree by proper selection of the collector load, however, in some cases the internal emitter to collector capacity of the transistor may be sufficiently high to cause undesired regeneration.

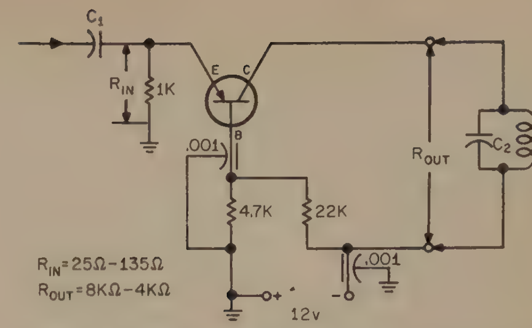


Fig. 1—*RF*-Amplifier, common base configuration, negative supply voltage.

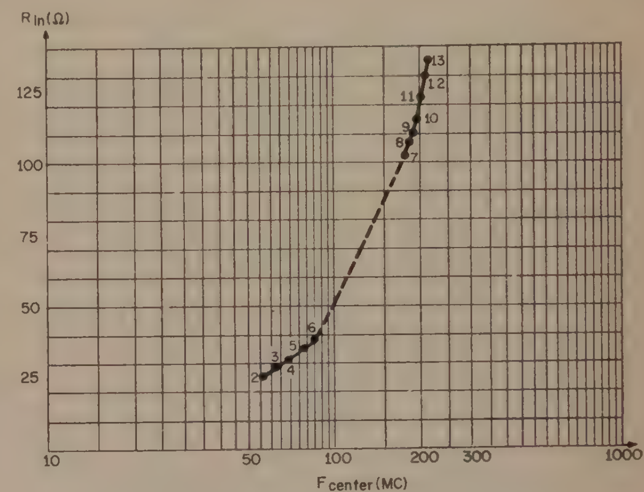


Fig. 2—Common base input resistance.

Oscillator

A TV oscillator circuit is shown in *Fig. 4*. The common base configuration is used. A small capacitor, 1 $\mu\mu f$, is added between collector and emitter to provide stable oscillations. Special care must be taken in order not to load down the oscillator output to such a level that oscillations are not sustained. This is prevented in the circuit of *Fig. 4*, by coupling the oscillator output through the small capacity C_o. In the TV tuner, in which this circuit is used, each channel is tuned by means of an individual oscillator coil L_o paralleled by a variable fine tuning coil, *F.T.*, which has a somewhat larger inductance. The oscillator is designed to provide an injection voltage of 150-500 *mv* across the 62$\mu\mu f$ matching capacitor in the emitter circuit of the mixer. Injection voltages of this order have been found to give maximum conversion gain. A common base mixer stage is shown in *Fig. 4* which is designed to convert TV *rf* frequencies to a 45 *mc if* frequency. Regeneration, gain and loading are controlled by the output tank which consists of capacitor C_{M3} and inductor L_{M3}. Since the value of C_{M3} will, to some extent, determine the oscillation threshold of the mixer stage, it should be considered critical. It also serves to swamp out variations in the mixer output capacity.

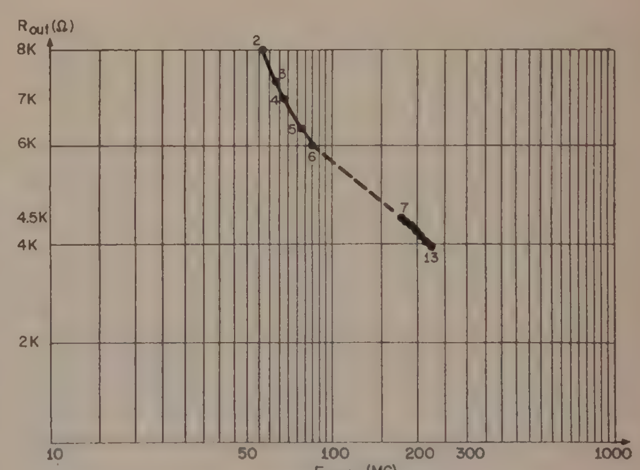


Fig. 3—Common base output resistance.

RF Amplifier

An *rf* amplifier utilizing the common emitter connection is shown in *Fig. 5*. The common emitter configuration has the advantage of offering a smaller (and falling) input impedance change over the *vhf* band. The impedance changes between about 135 and

60 ohms between channels 2 and 13. The smaller input impedance change afforded by the common emitter connection simplifies the problem of providing a match at the input. The typical variation in input resistance with frequency of the Philo T1694 is shown in *Fig. 6*. The output impedance of the grounded emitter amplifier changes from about 3 *K* to 1.2 *K* as shown in *Fig. 7*. Since the input signal is relatively out of phase with the output signal in the grounded emitter connection, an internal negative feedback takes place and the amplifier displays degenerative characteristics. It is generally necessary to use neutralization to overcome the inherent degeneration.

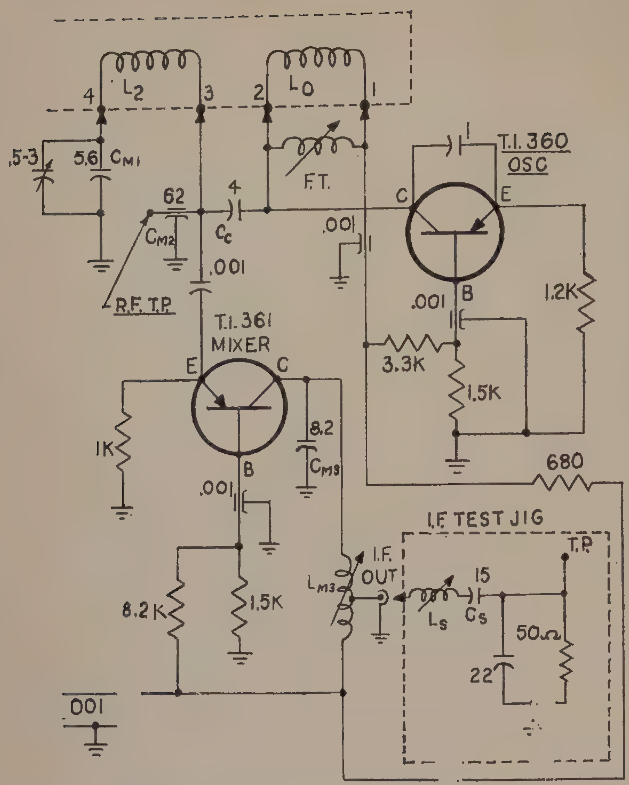


Fig. 4—Oscillator and mixer, Standard Coil TV mixer.

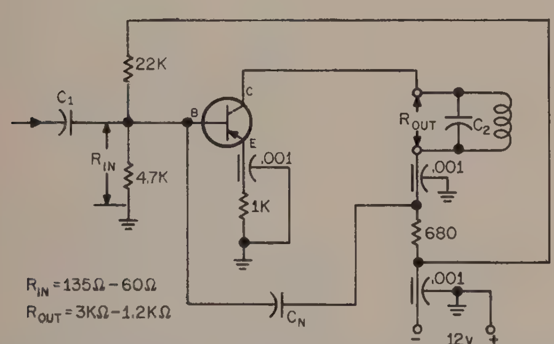


Fig. 5—RF-Amplifier, common emitter configuration, negative supply voltage.

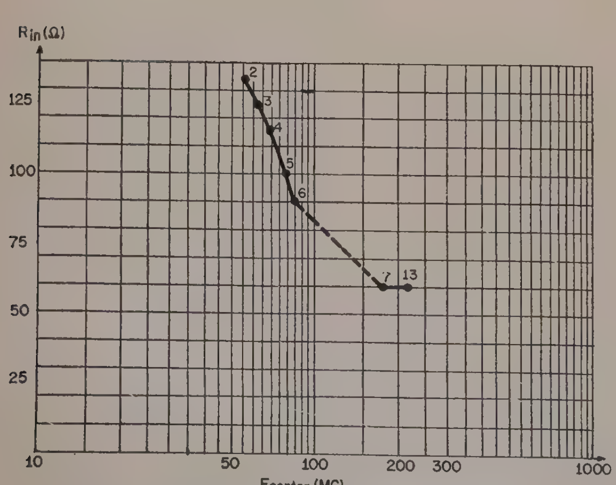


Fig. 6—Common emitter input resistance.

The Input Network

The antenna input network serves the following functions:

(1) It must transfer the antenna power to the transistor input with a minimum of insertion loss.

(2) It must match the antenna impedance to the transistor input impedance. Because of the varying transistor input impedance with frequency it must be designed to separately achieve this condition for each channel.

(3) It must prevent signals in the *if*, *fm* and broadcast bands from reaching the *rf* stage. To accomplish this it is desirable to incorporate two *if* traps, one *fm* trap and one *am* trap. Using such a trap configuration, it is possible to filter out the most likely interference frequencies before they reach the transistor.

(4) It must reject oscillator radiation and thus isolate the oscillator from the antenna. FCC regulations set the absolute maximum antenna radiation at 50 $\mu v/m$ on the low channels and 150 $\mu v/m$ on the high channels.

(5) It must be selective at the desired frequency.

Most of these requirements can be met but in some cases design compromises are necessary. It has been found that the series tuned input circuit is particularly desirable in achieving the necessary characteristics.

It is sometimes helpful in the design of a TV tuner to use a different type of matching network for the high and low channels. Two satisfactory networks are shown in *Fig. 8*. In the low channel circuit of *Fig. 8A*, the tuning coil, L_T, is placed in parallel with the input and resonates C_1 and C_2 in parallel. For the high channels a pi configuration is shown in *Fig. 8B* wherein the tuning coil L_T is placed in series with the input.

It is important that the input network provide good match, since minimum noise figure is a prime requisite in a well designed tuner. Gain may be recovered in any of the later stages but there is no way to improve a poor signal to noise ratio except in the *rf* stage. It is, therefore, most important that the *vswr* be well controlled on all channels. The *vswr* should not be permitted to exceed 2:1 on any channel.

A Complete TV Tuner

Let us now consider the design of a complete TV tuner. A schematic for a turret tuner is shown in *Fig. 9*. In this circuit, the balanced 300 ohm input is transformed to an unbalanced 300 ohm output by means of a balun transformer. In order to keep cross-modulation sources to a minimum two *if* traps and one *fm* trap have been incorporated in the input circuit. The input network uses the configurations which were previously discussed in *Fig. 8*. The *rf* stage is operated with forward *agc*. The series collector resistor, R_N, is used to drop the collector voltage for *agc* purposes. Capacitor C_D and C_N provide an out of phase feedback to neutralize the amplifier.

The use of a fixed neutralization capacitor for all channels does not provide the maximum possible gain. A separate neutralizing capacitor for each channel or at least for the lower and higher bands is advisable but sometimes impractical.

The *rf* output is inductively coupled to the mixer input coil L_2. Capacitors C_{M1} and C_{M2} form a capacitor divider network which serves to match the input impedance of the mixer. The oscillator signal is injected across C_{M2}. The mixer is designed to drive the *if* load impedance consisting of a 51 ohm resistor paralleled by a 15 $\mu\mu f$ capacitor. A low-side, capacitive coupling circuit is employed together with a series tuned circuit (L_S and C_S). The tuner shown in *Fig. 9* requires a positive supply voltage of 15 *v*. Similar tuners, operated from a negative supply, have been designed. It should be pointed out that the voltage drop across R_N dictates the high supply voltage.

A TV tuner using negative *agc* is shown in *Fig. 10*. This tuner operates with a 12 *v* supply. This circuit is similar to the circuit of *Fig. 9* except that a considerably smaller resistor is used in the collector supply line. Also, a broadcast trap has been added across

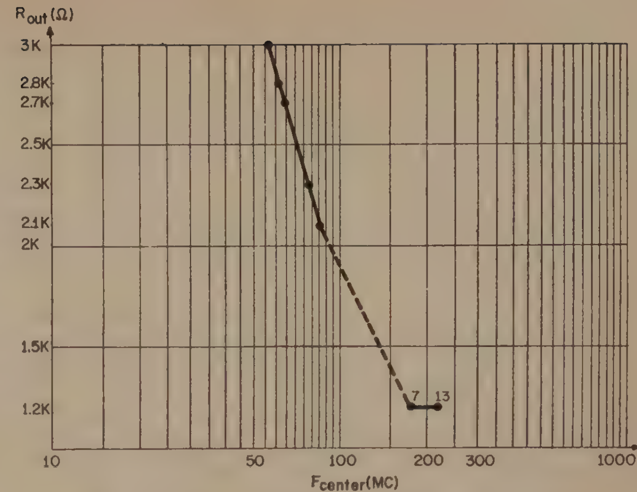
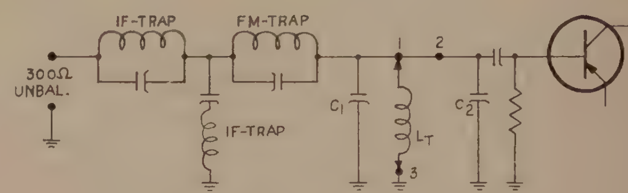
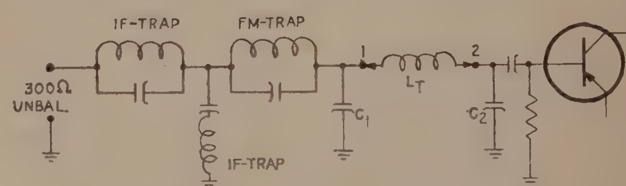


Fig. 7—Common emitter output resistance.



(A)



(B)

Fig. 8—Input matching networks, common emitter.

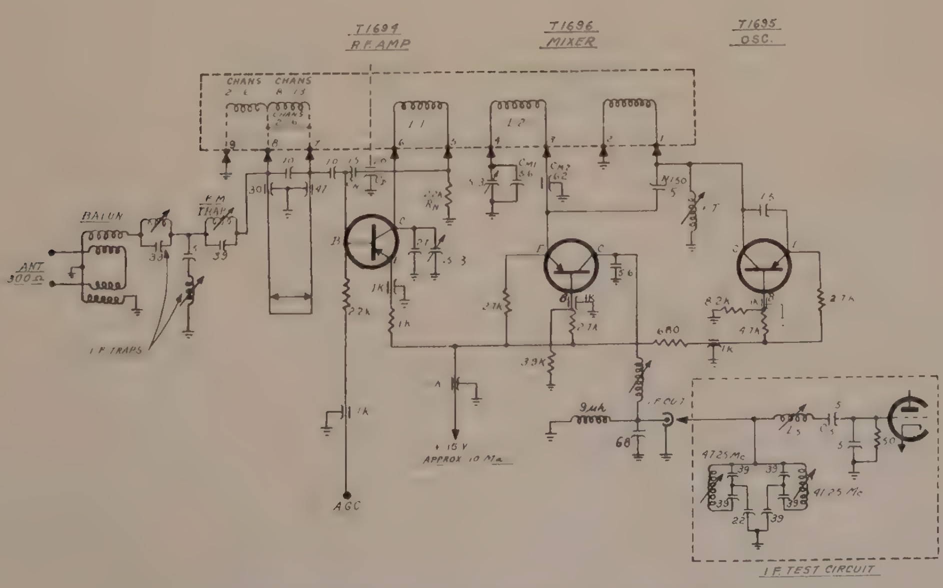


Fig. 9—TV tuner using a positive 15 volt supply.

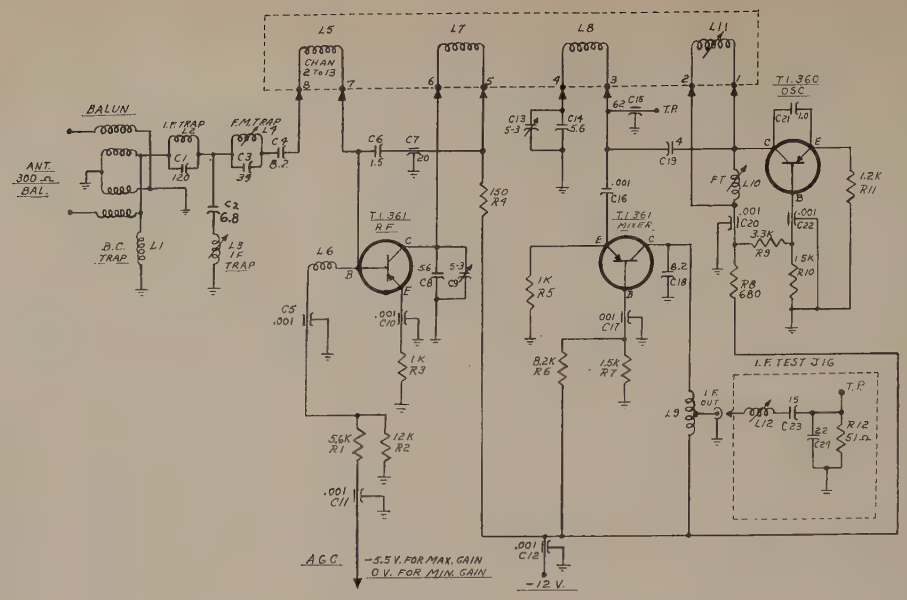


Fig. 10—TV tuner using negative AGC.

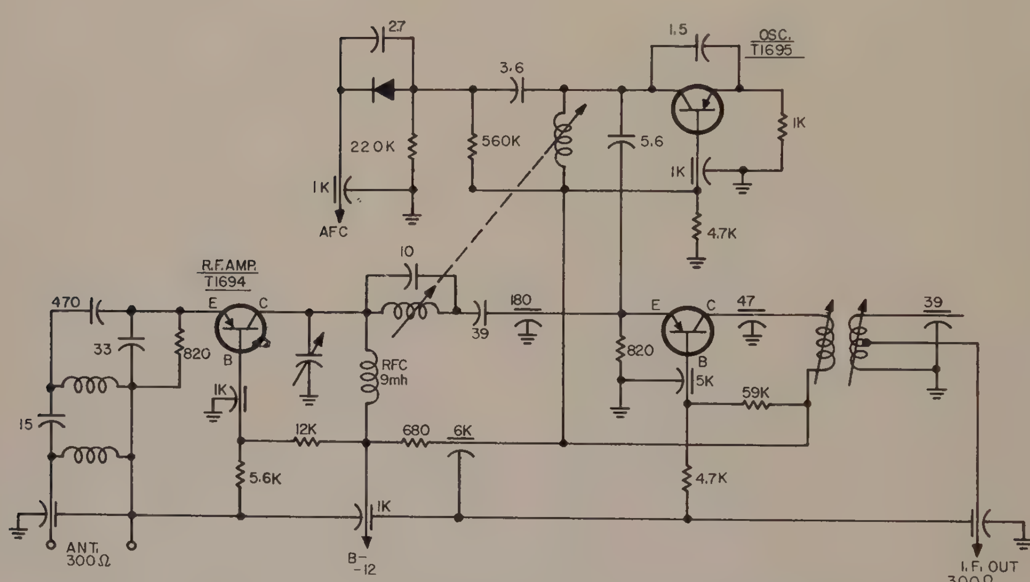


Fig. 11—Complete FM tuner designed for operation in the commerical FM band (88-108 mc).

the input circuit to reduce the possibility of cross modulation arising from this source.

An FM Tuner

A complete *fm* tuner designed for operation in the commercial *fm* band (88-108 *mc*) is shown in *Fig. 11.* Similar circuits can be used in portable and mobile *fm* communications systems at other frequencies. The circuit shown consists fundamentally of a broad band input circuit, a slug tuned *rf* interstage circuit and separate oscillator and mixer stages. In this tuner the oscillator output is connected to the mixer emitter through a capacitive voltage divider. It appears that more uniform oscillator injection can be achieved when capacitive coupling is used. From a production cost standpoint, capacitive matching also seems to be most desirable. The interstage network between the *rf* amplifier and the mixer is designed to match the collector output resistance of the *rf* output stage to the lower input impedance of the mixer with a minimum of insertion loss. It is also designed to reduce the oscillator output reaching the input of the *rf* stage. This is accomplished by the parallel trap which doubles as a section of the pi network. Since the oscillator frequency is above the *rf* signal this trap attenuates most of the oscillator radiation. In other respects the coupling network is a conventional pi matching section. The oscillator and mixer circuits

CHAN UNIT	VOLTAGE GAIN RATIO	NOISE FACTOR DB	BAL I.F. REJ. DB	VSWR Worst	BAL TO UNBAL DB	MAXIMUM GAIN REDUCT'N DB	GAIN REDUCT'N @ Max DBOV	IMAGE REJ. DB	FINE TUNING RANGE MC	POWER GAIN DB
E_c	- 5.5v	- 5.5v	- 5.5v	-5.5v	- 5.5v	forward	negative	- 5.5v	- 5.5v	- 5.5v
2	12.5	6.0	40	1.8/1	39	"	49	>70	3.0	36
3	10.0	6.0	49	1.5/1	47	"	49	>70		34
4	9.0	6.5	55	1.35/1	48	"	49	>70		33
5	9.0	6.5	60	1.2/1	55	"	47	>70		33
6	8.0	6.5	47	1.1/1	57	"	46	>70	2.5	32
7	3.2	8.0	57	1.1/1	33	"	41	58	2.6	24
8	3.2	8.0	57	1.1/1	33	"	40	59		24
9	2.8	8.0	66	1.2/1	32	"	40	60		23
10	2.8	8.5	63	1.1/1	30	"	40	61		23
11	2.5	8.5	60	1.1/1	31	"	41	60		22
12	2.0	9.0	62	1.1/1	30	"	40	60		20
13	1.2	10.0	62	1.1/1	31	"	42	60	2.6	18

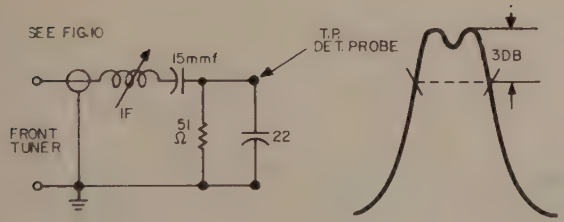


Fig. 12—Typical performance data for a TV tuner of the type shown in Fig. 10.

themselves are very similar to the circuits described in the TV tuner. The output of the mixer is coupled through a matching transformer to the 300 ohm input impedance of the *if* amplifier. Regeneration may be applied from the secondary winding of the mixer output transformer to the input. Such regeneration results in an appreciable gain increase and a narrower mixer band.

Overall Performance

In *Fig. 12,* typical performance data is shown for a TV tuner of the type shown in *Fig. 10.* As can be seen, the noise figures range from about 6 *db* on the lower channels to 10 *db* on the high channels. While improvements are continuously being made the transister tuner has become competitive with the tube tuners and it appears that its application in the conventional home TV sets is only a matter of time.

Acknowledgement

Grateful appreciation is extended to C. D. Nestlerode and C. D. Simmons for their help in editing this paper, and to Mary Stonecypher for the art work.

Application of Transistors To Video Equipment

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Part 3

This is the third and concluding article of a series describing developments in the transistorization of television transmitting equipment in Japan. The portable camera-transmitter and the sync-signal generator were described in the first two installments. This concluding article in the series discusses the image orthicon camera.

The Image-Orthicon Camera

The transistorized image-orthicon camera (TIO) illustrated in *Fig. 15* was designed mainly for mobile airborne telecasting. This new camera employs a 5″ monitor tube (5AYP4) at the right side of the image-orthicon assembly. The height of the camera has been reduced for easy tilt.

The physical dimensions of the camera (TIO) are 440 x 190 x 300 mm. and its weight is about 16 Kg. The electrical features are the same as those of any conventional image-orthicon camera using electron tubes, but its power consumption is only about 50 W, as a result of its transistorization.

Since the weight, capacity and the power consumption of the camera are no more than a fraction of existing cameras, the cameraman can easily track his subject with the camera mounted on a small tripod.

The optical system uses the zoom lens exclusively, so that the cameraman can set an optical focus and picture angle in one action, adjusting the zoom rod with his right hand.

The interior arrangement of TIO is as follows: A cylinder containing the image-orthicon assembly is located at the right side. A preamplifier panel, a deflection panel and an image-orthicon control panel are mounted around it.

On the right side, as seen in *Fig. 15*, is a 5″ monitor tube 5AYP4, its accessory circuit, a regulator panel for camera power source and a converter for high voltage. A camera cable which connects the camera with the camera control unit (CCU) is very thin, its diameter being 12 mm. It has 12 contacts.

Circuit Configuration of TIO

A block diagram of the T10 is shown in *Fig. 16*. In this camera, each electrode potential control of the image-orthicon is in the camera in order to simplify the circuit and to make a small diameter cable possible. The control knobs, concerned with the image-orthicon operation, are of the semi-fixed type, and with a few exceptions, are located in the camera. These exceptions are the "beam focus," "beam" and "target set switch" in the rear end of the camera.

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This design brings the camera one step closer to the "controlless" type by employing a stable transistorized circuit and series regulator circuits.

Video Amplifier

The preamplifier, *Fig. 17*, has 7 stages and a current gain of about 50 *db*. It provides a diode clamp circuit to prevent the initial shock from high voltage supply of the camera tube from damaging the transistors. The preamplifier panel also contains a target blanking amplifier, an image-orthicon protector and a dynamic focusing circuit.

Horizontal Deflection Circuit (Fig. 18)

The horizontal deflection power of the image-orthicon is about 2 mhA, which is about 10 times that of 1″ vidicon. The horizontal deflection coil, designed for the transistor circuit, has an inductance of 250 μ*h* and a *d-c* resistance of 1 ohm. The horizontal deflection circuit utilizes a transistor with a superior switching characteristic and operates at high effi-

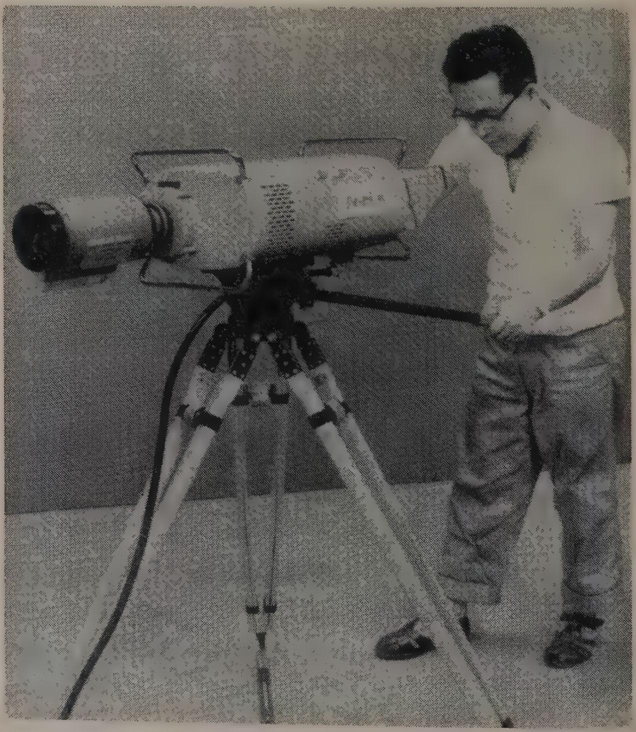


Fig. 15—Transistorized image-orthicon camera.

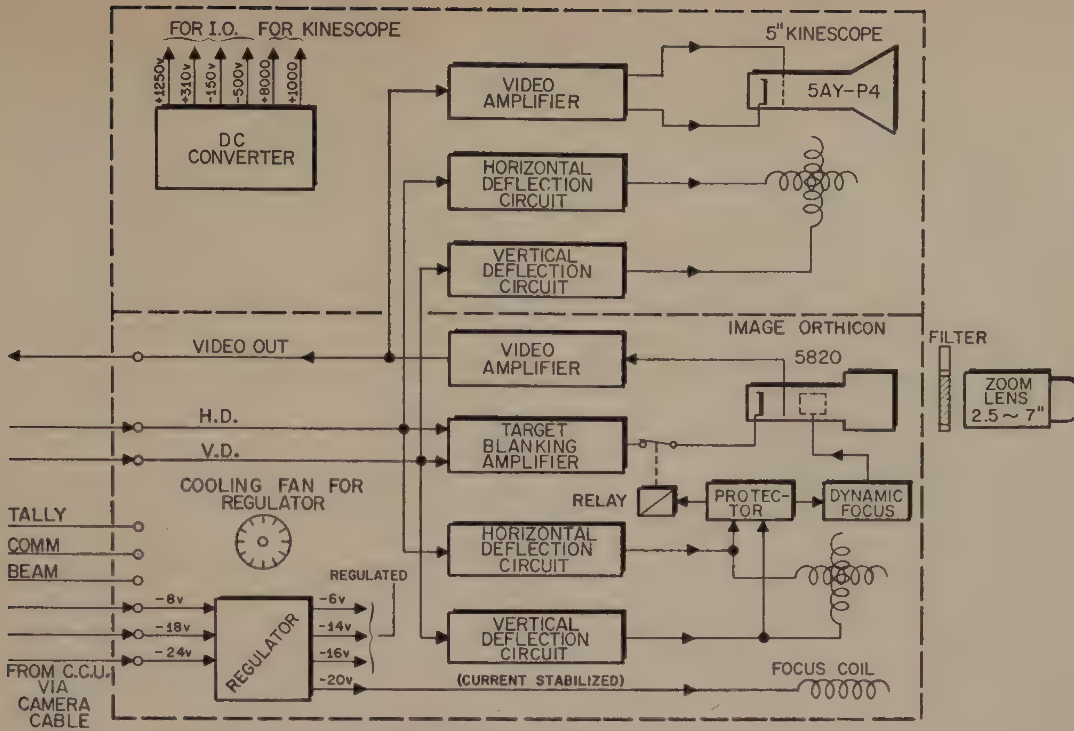


Fig. 16—Block diagram of the T.I.O.

ciency. However, under the present situation, a transistor for high power horizontal deflection should be selected from among available transistors.

During the retrace period, a relatively large voltage, which is a half cycle of a free oscillation, appears on the collector. The yoke inductance must be adjusted so that the peak voltage does not exceed the collector breakdown voltage.

The method for reducing the fly-back voltage pulse on the collector is seen in *Fig. 18*. The stepdown transformer, which has a 1:1.5 ratio, prevents excessive fly-back voltage on the collector, although the collector current increases inversely. The peak-to-peak value of horizontal saw-tooth current is 2.8 amperes thru the deflection coil and the fly-back pulse voltage appearing at the collector is —60 volts.

Since the value of capacitor C is related to the retrace period and the fly-back voltage, a selected capacitor should extend the retrace period as far as it is permissible, in order to minimize the transient fly-back pulse. The retrace period of this deflection circuit is about 13 percent of one horizontal scanning period.

Vertical Deflection Circuit

The vertical deflection circuit employs a shunt-regulated circuit, similar to that used for the audio output. The peak-to-peak value of the vertical saw-tooth

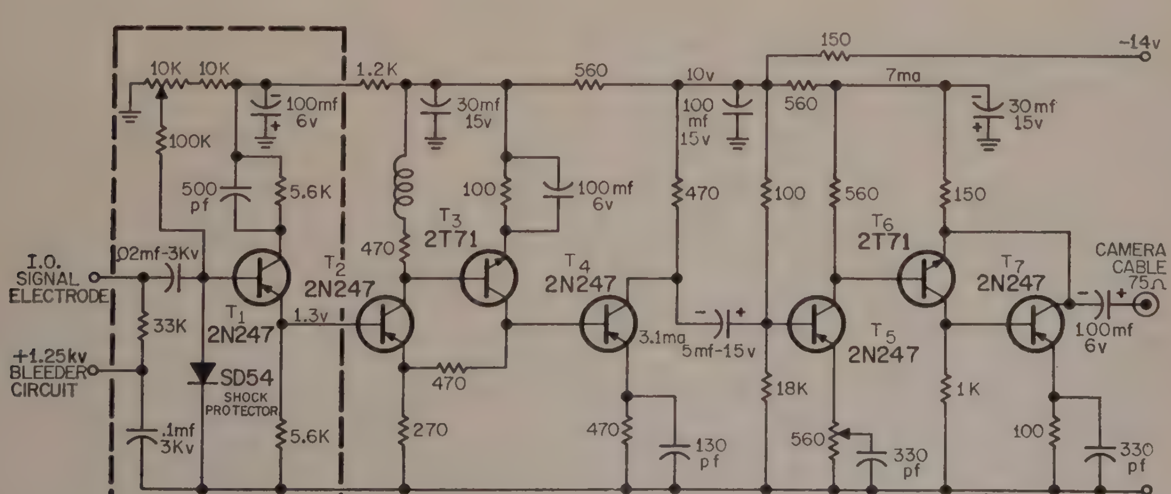


Fig. 17—Video head amplifier of the T.I.O.

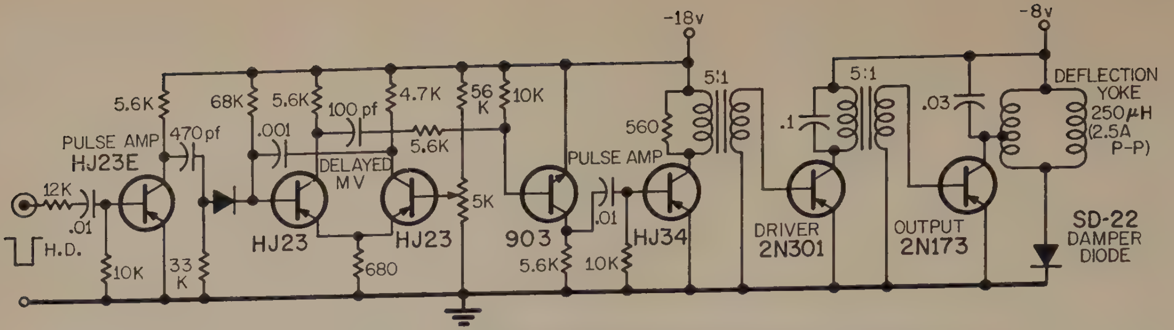


Fig. 18—Schematic diagram of the horizontal deflection circuit.

is 700 *ma* through the vertical deflection yoke which has an inductance of 50 *mh* and a resistance of 40 ohms. The deflection power for the 5″ monitor tube 5AYP4 is almost identical with that of the image-orthicon, but the use of a permanent magnet centering device, permits the flow of the *d-c* component in the deflection coil.

Power Supply (Fig. 19)

All circuits are supplied through the voltage regulator circuits and therefore the stability of TIO circuit is very high against the fluctuation of the battery voltage. Voltage regulator circuits are provided for —20*v*, —15*v* and —6*v*. The —6 volts power line which contains a —6.5*v* silicon reference diode, serves as the reference for the other regulators. The other regulators employ 2-stage *d-c* amplifiers and a series transistor.

The capacity of battery should be 24 *AH* (24*v*) for operating the TIO camera for about 5 hours.

The converter (T13 and T14) supplies 1250*v*, 330*v*, —150*v* and —550*v* to the image-orthicon and also converts low *d-c* voltage to 8 kv and 3 kv for the 5″ picture tube.

A forced cooling fan is available to make the transistor power dissipation higher, and two other fans are employed for cooling the image-orthicon assembly and the horizontal deflection output transistor.

Acknowledgement

The authors wish to thank Mr. T. Nomura, Vice Director of the NHK Technical Research Laboratory, Dr. S. Miki, Chief of the TV Research Section and Mr. T. Ishibashi, Vice-Chief of the TV Research Section for guidance in this project and for permission to publish this article.

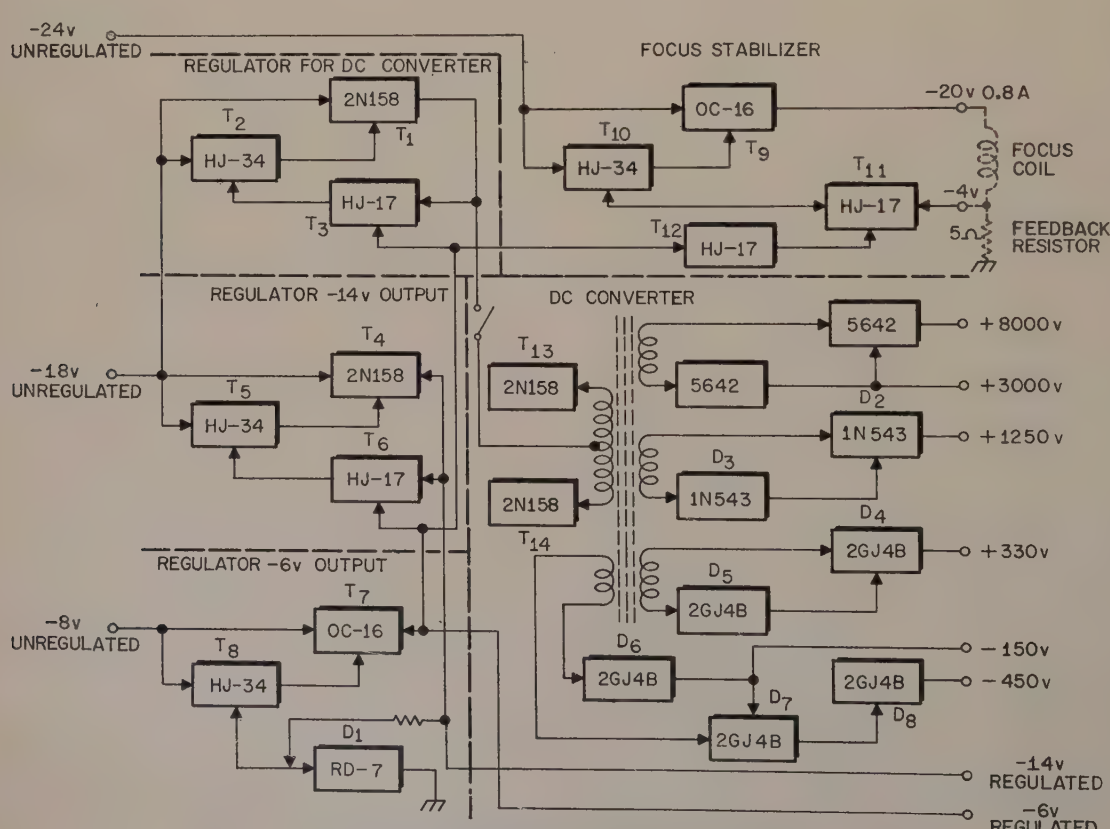
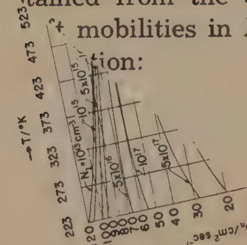


Fig. 19—Block diagram of the power supply.

Temperature Dependence of Ca
Mobilities, Diffusion Consta
Conductivities in Germanium a

ꟷtained from the carrier
mobilities in *Figs. 2*
tion:



W. W. GÄRTNER*

CARRIER DENSITIES, mobilities, diffusion constants and conductivities are important design parameters in all semiconductor devices of the conventional and the micro-electronic type. The temperature dependences of the material properties determine the temperature sensitivity of the final devices. The computation of these dependences therefore is necessary in most design work to minimize the temperature variations in the electrical characteristics. As an aid in these time-consuming computations and for rapid estimates the seven graphs in this article show the above mentioned properties for impurity concentrations usually encountered in semiconductor devices and over the temperature range usually encountered in device operation. They have been calculated from the latest accepted formulae which are briefly summarized below:

Carrier Densities (Fig. 1)

The carrier densities are determined from

$$np = n_i^2$$

and the condition for electrical neutrality,

$$n + N_a = p + N_d.$$

n is the electron density; p is the hole density; N_a is the ionized acceptor density; N_d is the ionized donor density. In n-type material $N_d = N_I$ (see *Fig. 1*) and $N_a = 0$; in p-type material $N_a = N_I$ and $N_d = 0$; n_i is the intrinsic carrier density, given by:

$$n_i^2 = 3.1 \times 10^{32} \times T^3 \times \exp(-9101/T) \text{ cm}^{-6} \text{ in germanium}^{(1)}$$

and

$$n_i^2 = 1.5 \times 10^{33} \times T^3 \times \exp(-14028/T) \text{ cm}^{-6} \text{ in silicon}^{(2)}$$

where T is the temperature in degrees Kelvin.

---

*Formerly Chief Scientist, Solid State Devices Division, U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J. Dr. Gartner is now associated with CBS Laboratories as Manager of their Electronic Semiconductor Department.

Formulae and graphs given in this article will also appear in the college textbook "Transistors: Principles, Design and Applications" by W. W. Gärtner to be published by D. Van Nostrand, 1960

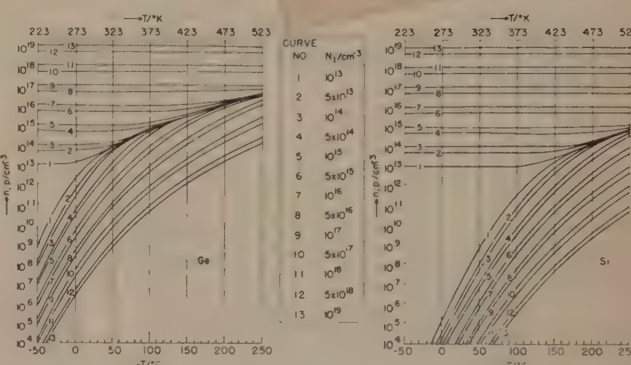


Fig. 1—Majority and minority carrier densities, N and P, in germanium and silicon with various impurity concentrations, N_I, as a function of temperature.

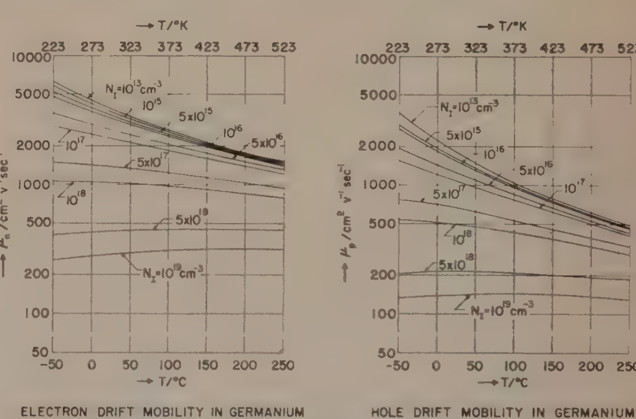


Fig. 2—Electron and hole drift mobilities, μ_n and μ_p, in germanium with various impurity concentrations, as a function of temperature.

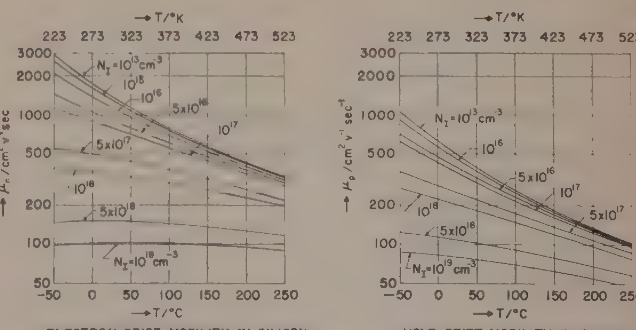


Fig. 3—Electron and hole drift mobilities, μ_n and μ_p, in silicon with various impurity concentrations, as a function of temperature.

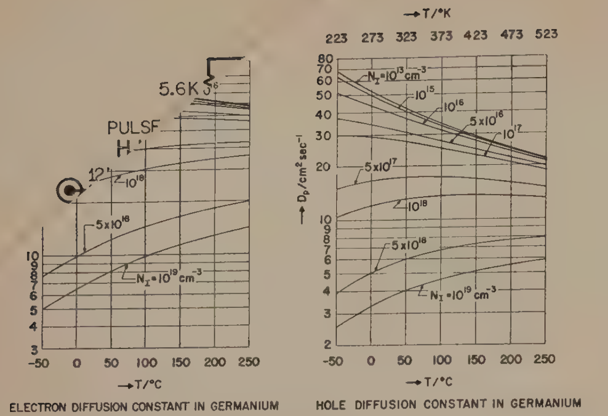


Fig. 4—Electron and hole diffusion constants, D_n and D_p, in germanium with various impurity concentrations, as a function of temperature.

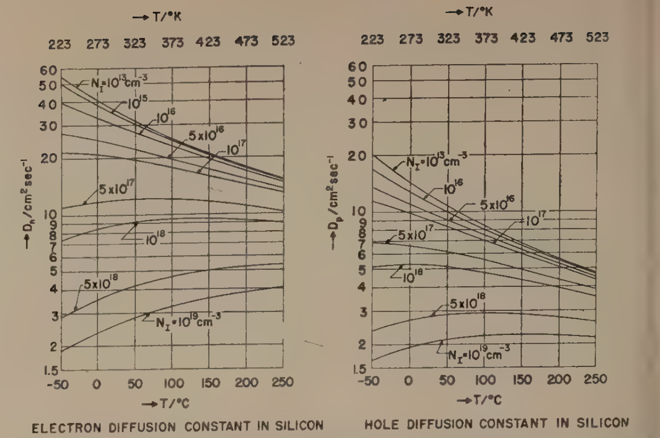


Fig. 5—Electron and hole diffusion constants, D_n and D_p, in silicon with various impurity concentrations, as a function of temperature.

Drift Mobilities (Figs. 2 and 3)

The drift mobilities are obtained as a combination of lattice and impurity mobilities according to the formula[3]

$$\mu = \mu_L \left[1 + M^2 \left\{ CiM\cos M + SiM\sin M - \tfrac{1}{2}\pi \sin M \right\}\right]$$

where

$M^2 = 6\mu_L/\mu_I$; Si and Ci are the integral sine and cosine respectively. The lattice mobilities are given by

$$\mu_{nL} = 4.9 \times 10^7 \times T^{-1.66}\ \mathrm{cm^2 \cdot V^{-1} \cdot sec^{-1}}$$

for electrons in Ge[4];

$$\mu_{pL} = 1.05 \times 10^9 \times T^{-2.33}\ \mathrm{cm^2 \cdot V^{-1} \cdot sec^{-1}}$$

for holes in Ge[4];

$$\mu_{nL} = (2.1 \pm 0.2) \times 10^9 \times T^{-2.5\pm0.1}\ \mathrm{cm^2 \cdot V^{-1} \cdot sec^{-1}}$$

for electrons in Si[5];

$$\mu_{pL} = (2.3 \pm 0.1) \times 10^9 \times T^{-2.7\pm0.1}\ \mathrm{cm^2 \cdot V^{-1} \cdot sec^{-1}}$$

for holes in Si[5].

The impurity mobilities are calculated from[6]

$$\mu_I = \frac{8\sqrt{2}\,\epsilon_0^2\,\kappa^2 (kT)^{3/2}}{\pi^{3/2} N_I q^3 m^{\frac{1}{2}}_{\mathrm{eff}} \ln\left[1 + \left(\dfrac{3\,\epsilon_0\,\kappa\,kT}{q^2 N_I^{1/3}}\right)^2\right]}$$

where ε_0 is the permittivity of free space ($=8.854 \times 10^{-12}$ farad.m^{-1}); κ is the dielectric constant; N_I is the density of ionized impurity atoms; m_{eff} is the effective mass of the carriers (taken equal to .25 m_0 for electrons in Ge, and equal to $1 m_0$ in all other cases; m_0 is the mass of the free electron, $m_0 = 9.11 \times 10^{-31}$ kilogram); q is the electronic charge ($= 1.6 \times 10^{-19}$ coulomb); k is Boltzmann's constant ($= 1.38 \times 10^{-28}$ watt.sec.deg^{-1}).

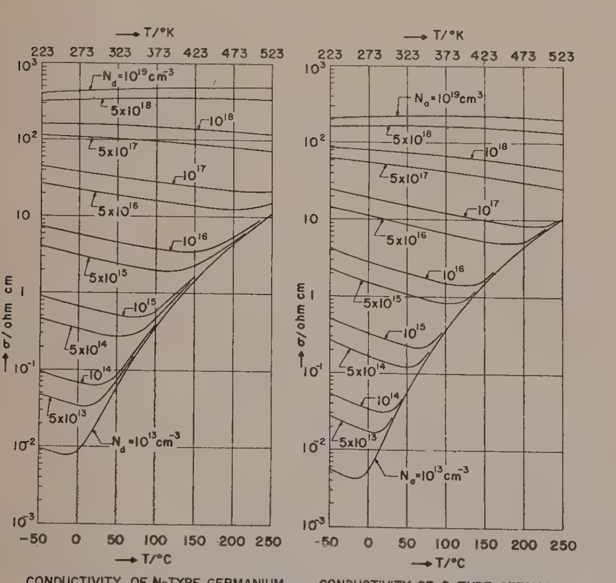


Fig. 6—Conductivity of germanium as a function of temperature.

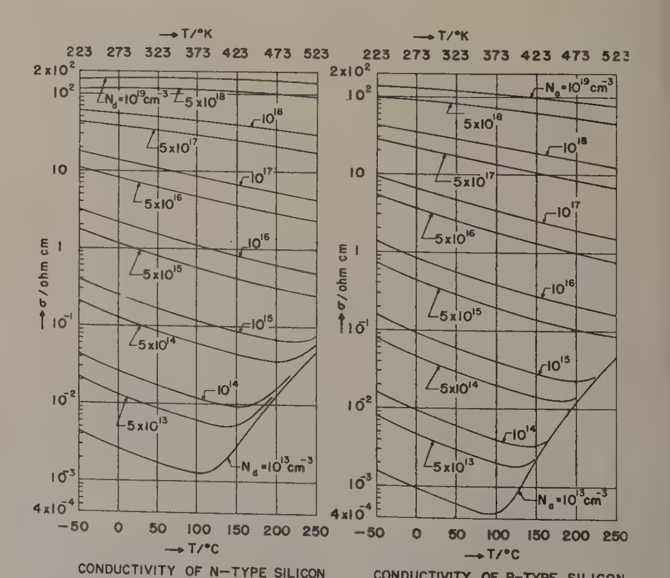


Fig. 7—Conductivity of silicon as a function of temperature.

Diffusion Constants (*Figs. 4 and 5*)

The diffusion constants are obtained from the corresponding drift mobilities in *Figs. 2* and *3* through the Einstein relationship:

$$D = (kT/q)\mu$$

Conductivities (*Figs. 6 and 7*)

The conductivities are obtained from the carrier densities in *Fig. 1* and the drift mobilities in *Figs. 2* and *3* through their defining equation:

$$\sigma = q(\mu_n n + \mu_p p)$$

References

1. F. J. Morin and J. P. Maita, *Phys. Rev.* **94**, 1525 (1954).
2. F. J. Morin and J. P. Maita, *Phys. Rev.* **96**, 28 (1954).
3. P. P. Debye and E. M. Conwell, *Phys. Rev.* **93**, 695 (1954); H. Jones, *Phys. Rev.* **81**, 149 (1951); V. A. Johnson and K. Lark-Horovitz, *Phys. Rev.* **82**, 977 (1951).
4. F. J. Morin, *Phys. Rev.* **93**, 62 (1954); M. B. Prince, *Phys. Rev.* **92**, 681 (1953).
5. G. W. Ludwig and R. L. Watters, *Phys. Rev.* **101**, 1699 (1956).
6. E. M. Conwell and V. F. Weisskopf, *Phys. Rev.* **77**, 388 (1950).

Transistor-Capacitor Shift Register*

RICHARD W. HOFHEIMER**

A shift register is described in which capacitors are used as the information storage elements. The chief advantages are circuit simplicity and high bit rate capability.

The novel feature of the transistor-capacitor shift register shown in *Fig. 1* is the use of capacitors as the information storage elements. Shift registers of this type can be constructed with readily available components, and should lend themselves easily to miniaturization techniques. They are low in power consumption, and can be operated at high speeds. The breadboard model of the transistor-capacitor shift register was recirculated at bit rates up to 20 megabits per second.

Fig. 1 shows a four-stage shift register. Its operation is as follows. The right-hand plates of capacitors *C*1, *C*2, *C*3, and *C*4 are always held to within approximately one volt of ground potential, either by the base-emitter diodes of the transistors, or by diodes *D*1, *D*3, *D*5, and *D*7. Assume that all the capacitors are charged so that their left-hand plates are at a potential of minus seven volts. Under these conditions, a negative pulse applied at the input at "B" pulse time causes the collector of *T*1, and hence the left-hand plate of *C*1, to rise to ground potential. The next

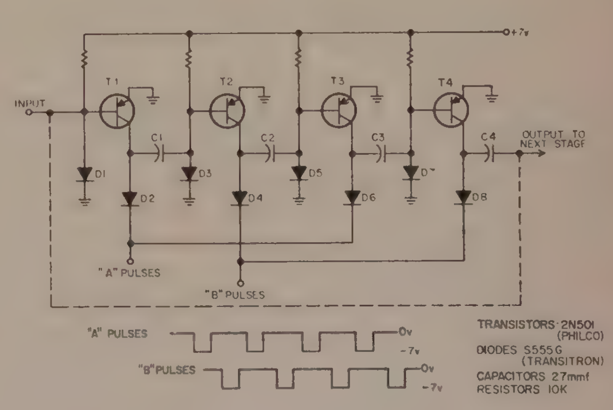


Fig. 1—Transistor-capacitor shift register.

*The work reported in this article was performed at Lincoln Laboratory, a center for research operated by Massachusetts Institute of Technology with the joint support of the U. S. Army, Navy, and Air Force.

**Formerly Staff Member, Lincoln Laboratory, Massachusetts Institute of Technology. Mr. Hofheimer is now associated with Non-Linear Systems, Inc., Del Mar, Calif.

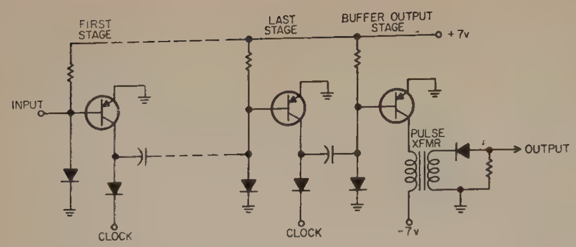


Fig. 2—Transistor-capacitor shift register with buffer output stage.

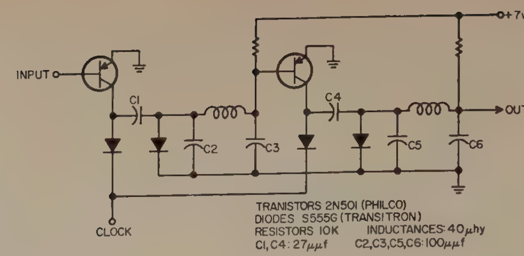


Fig. 3—Transistor-capacitor shift register using lumped-constant delay lines in alternate stages.

"A" clock pulse restores $C1$ to its original charge, and in the process, applies a small negative pulse to the base of $T2$. This, in turn, causes the left-hand plate of $C2$ to rise to ground potential. The next "B" clock pulses restores $C2$, and propagates the pulse to the next stage. In this manner, any pulses introduced at the input are propagated along the shift register. If no pulses are introduced at the input, no pulses are propagated. Thus any pattern of pulses and no pulses can be propagated. The value of the resistors in *Fig. 1* is related to the clock pulse shape. If the leading edge of the clock pulse is very steep, the value of the resistors may have to be reduced to avoid propagating a pulse where none is intended. A satisfactory value is easily determined experimentally.

Since each clock pulse resets half of the shift register stages an n-stage shift register can store only $n/2$ binary digits. Thus the four-stage shift register shown in *Fig. 1* can store 2 bits. If a shift register contains an even number of stages, the output can be connected to the input to obtain recirculation. This connection is shown by the dotted line in *Fig. 1*.

Fig. 2 shows one method of getting information out of a transistor-capacitor shift register. This method makes use of a buffer stage with a transformer output.

The shift register shown in *Fig. 1* uses two transistors per bit, and two sets of clock pulses. However, by substituting lumped-constant delay lines for alternate stages of the shift register, a technique which is used in magnetic core shift registers, a transistor-capacitor shift register can be constructed using only one transistor per bit, and requiring only one set of clock pulses.† Such a shift register is shown in *Fig. 3*.

The advantages and disadvantages of the transistor-capacitor shift register can probably best be evaluated by comparison with those of the magnetic core shift register. Both types of shift registers share the advantage of low power consumption. Both types share the serious disadvantage that their performance depends on the clock pulse shape. A clock pulse having too steep a leading edge can cause a pulse to be propagated when none is intended. On the other hand, a clock pulse having a leading edge which is not steep enough can fail to propagate a pulse when one is intended. In both types of shift registers, the load presented to the clock pulse source is a function of the information content of the register. This, in turn, aggravates the problem of pulse shaping mentioned just above.

The transistor-capacitor shift register can be operated at higher bit rates than magnetic core shift registers. Currently available magnetic core shift registers have an upper limit of approximately 500,000 bits per second. The transistor-capacitor shift register will operate very satisfactorily at 5 megabits per second. An upper limit might lie between 15 and 20 megabits per second.

The magnetic core shift register has the advantage that its clock pulse can be interrupted for indefinitely long periods of time without loss of information. This is not true for transistor-capacitor shift registers. In applications where clock pulse interruption for long periods of time is not necessary, the transistor-capacitor shift register should be very competitive with the magnetic core shift register. Transistor-capacitor shift registers should be especially useful in systems employing pulse logic as described by W. N. Carroll and R. A. Coopper.*

†The suggestion to substitute delay lines for alternate stages of the transistor-capacitor shift register was made by Kenneth E. Perry.

*W. N. Carroll and R. A. Coopper, "Ten Megapulse Transistorized Pulse Circuits for Computer Applications," *Semiconductor Products* (July/August 1958).

Applications Engineering Digests

APPLICATIONS ENGINEERING DIGEST NO. 41

Simplifying Voltage Regulation; Hoffman Electronics Corp., El Monte, California. (E. F. Koshinz)

The use of Zener regulators as replacements for conventional gas-filled voltage regulator (VR) tubes is becoming increasingly well known. Below is an application concerning such a shunt-type regulator used in conjunction with a high power transistor that allows for considerable variation in output voltage selection by use of various low power Zener units.

In the circuit in *Fig. 41.1*, the Zener regulator, used as a replacement for the conventional gas-filled regulator tube, may be selected to obtain regulated output voltages from 6.2 to 200 volts (Hoffman 10, 1 and ¼ watt series). This is often an advantage, since the common gas-filled regulator tube voltages of 75, 90, 105, etc., do not meet some design requirements. As Hoffman Zener regulators are available in high power units, with low Zener impedance, a considerable amount of flexibility is now possible in the design of power supplies of this type.

An improved circuit, *Fig. 41.2*, uses a transistor in conjunction with the Zener regulator. Here, an increase in R_L causes an increase in base current (i_b), which in turn causes a corresponding increase in collector current (βi_b). Thus, by selection of a high power transistor, voltage regulation over wide variations in load is now possible at essentially the reverse breakdown voltage of the selected Zener regulator.

As with the circuit of *Fig. 41.1*, a wide variation in regulated output voltage is possible by use of selected Zener regulators. In this case, however, the regulators may be of a low power type.

Equations for the circuit of *Fig. 41.2* are as follows:

Regulation

$$de_o = \frac{\delta e_o}{\delta V_s} dV_s + \frac{\delta e_o}{\delta I_L} dI_L$$

Voltage Stability Factor

$$\frac{\delta e_o}{\delta V_s} = \frac{R_b R_L}{R\,[R_L(\beta + 1) + R_b]}$$

Output Impedance

$$\frac{\delta e_o}{\delta I_L} = \frac{R R_b}{R_b + R(\beta + 1)}$$

where:
R_b = base resistance + Zener resistance

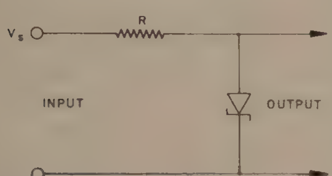


Fig. 41.1—Zener shunt regulator.

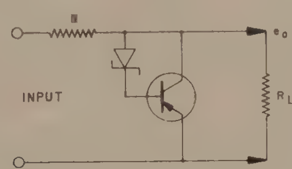


Fig. 41.2—Transistorized shunt regulator.

[Circle 198 on Reader Service Card]

APPLICATIONS ENGINEERING DIGEST NO. 42

Tunnel Diode Applications; Hughes Semiconductor Division, Newport Beach, California. (Carl D. Todd)

Tunnel Diode Amplifier

For purposes of illustration we can assume that the tunnel diode equivalent circuit is only the negative resistance shunted by the capacitance C_d. A very simple amplifier circuit might be that shown in *Fig. 42.1 (a)*. Its equivalent circuit is shown in *Fig. 42.1 (b)*. At the resonant frequency of the tank circuit consisting of the inductor, L, the diode capacitance, C_d, and the tuning capacitor, C, the equivalent circuit simplifies to that shown in *Fig. 42.1 (c)*.

The resulting power gain is given by the expression:

$$G = \frac{1}{1 - \frac{R_L}{r_d}}$$

which is plotted in *Fig. 42.2*. Note that as the value of the load resistance approaches the magnitude of the diode negative resistance, the gain will become infinite. Unfortunately, this produces an oscillator rather than the desired amplifier.

If the load resistor is slightly higher than the diode negative resistance, a phase reversal would result in the output signal. An unwanted effect is that

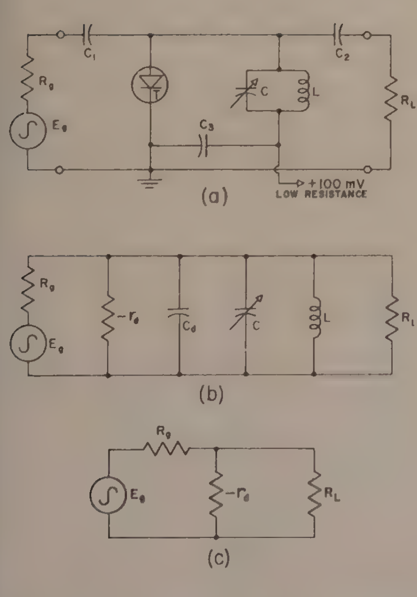


Fig. 42.1—(a) A tunnel diode amplifier and (b) its simplified a-c equivalent circuit, and (c) equivalent circuit at resonance.

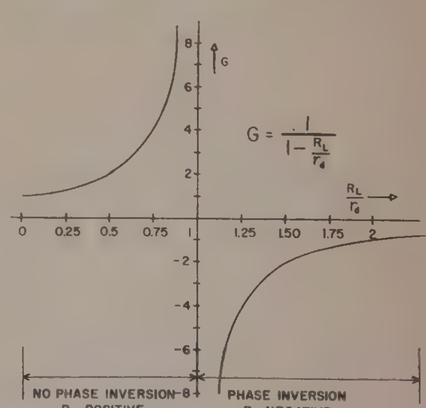


Fig. 42.2—Power gain as a function of relative load resistance.

the input resistance is negative with the result that instability will result.

Normally, the load resistor R_L is chosen to be slightly smaller than the magnitude of r_d, thus allowing the input resistance, R_i to be positive and no phase reversal will result.

Pulse Circuits

By proper choice of the load line, the tunnel diode may perform in a bistable, astable, or monostable mode. Their high speed and lack of storage time certainly interest the designers of computers, but new techniques will be necessary before full use of their capabilities may be made. A major problem is one of isolation of the input and output circuits.

One approach presently being used by Dr. Goto of Tokyo University is similar to that used in conjunction with Parametrons. This technique requires in effect a three-phase square wave source to supply cascaded stages in a sequential manner.

One possible monostable circuit is shown in *Fig. 42.3*. This circuit has been studied and will be reported on in a future publication. Use of tunnel diodes in bistable circuits capable of cascade counting operation, while possible, presents difficulties due to a lack of complementary components such as diodes. The backward diode which has a very low breakdown voltage and operates on the tunneling principle is a possible solution to this problem.

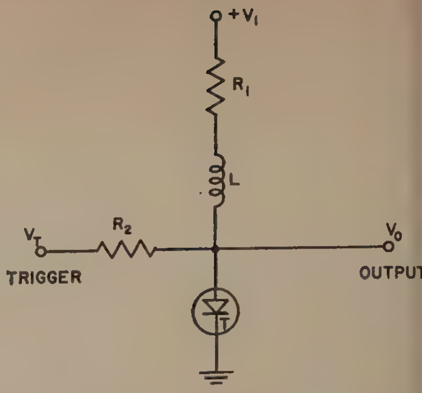


Fig. 42.3—The tunnel diode monostable circuit.

APPLICATIONS ENGINEERING DIGEST NO. 43

High Power VHF Transistor Amplifier Design; Fairchild Semiconductor Corp., Mountain View, California. (Paul J. Beneteau)

Amplifier Specifications

Frequency	65*mc*/sec
Source impedance	50 ohms
Load impedance	50 ohms
Power output	1.5 watts minimum
Power gain	10 *db*
Bandwith	5 *mc*

Design of Amplifier

Input Stage (see Fig. 43.1)

From the data sheet power gain curves, we observe that an operating point of $V_{CB} = 40$v and $I_B = 20$ ma is suitable. Although these are small signal characteristics, they will serve as first order guides in selection of circuit values. Further, we note from the input resistance characteristics that R_{iep} will be sufficiently near 50 ohms to make it unnecessary to use a matching network at the input. The input capacitance C_{iep} is of the order of 50μμf. To tune this out, we put a coil of —80 μμf in parallel with a 7-45 μμf trimmer. (The use of negative μμf for inductances is common, since most measuring instruments, e.g. the Boonton RX Meter and the Wayne-Kerr B-801 bridge, have indications in negative μμf rather than μh. It is then simpler to know which neutralizing capacitance to use.) Air Dux coils, sold by Illumitronic Engineering of Sunnyvale, California, are very convenient to use.

In the emitter circuit, we use a 1K 2w resistor (2 watt because we might want to try up to 40 *ma* current later on) by-passed by a 0.05 μf disc capacitor. It is very important in any *rf* amplifier construction to use capacitors that are non-inductive at the frequencies of interest and to use *rf* chokes that are resonant near these frequencies.

In the collector circuit, we use an *rfc* for the *d-c* bias, and the parallel coil and trimmer are merely to tune out the output capacitance of the transistor. The coil and trimmer from collector to base are to neutralize the y_{12e} component, as described in Fairchild Technical Memorandum #1 by G. Reddi. To properly neutralize the stage, an input signal is fed into the "Neutralizing Input" jack, and a sensitive detector (e.g. and Eddystone 770R receiver) is inserted at the input. The neutralizing capacitor is then set for minimum signal to the detector.

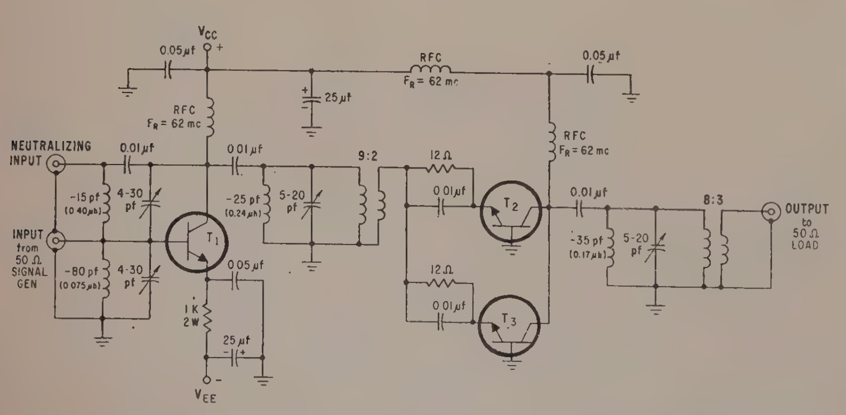


Fig. 43.1—65 *mc*/sec class "C" common base power amplifier for 2N698.

For matching, either a π or *L* reactive matching network can be used. Transformers are usually broader band, and are used in our circuits.

The interstage transformer must match the output resistance of the driver to the input resistance of the output stages. The output resistance will be somewhat higher than R_{oep}, since by definition, R_{oep} is the output resistance with the input short-circuited. If $R_{out} \approx 1.5$K and $R_{in} \approx 75$ ohms, (necessarily an average, since R_{in} is obviously very high when both transistors are cut off) then the transformer turns ratio will be

$$n = \frac{n_1}{n_2} \approx \sqrt{\frac{1500}{75}} = 4.5$$

Select $n_1 = 9$ and $n_2 = 2$.

Output Stage

The input capacitance need not be neutralized since the trimmer at the output of T_1 will do this more effectively in view of the 4.5:1 ratio which reduces the input capacitance of T_2 and T_3 by 20:1 as viewed from T_1. Both transistors must be biased separately. The output is similar to that of T_1. The *rfc* permits shunt feeding the *d-c* current, while the coil and capacitor at the output are again intended to tune out the output capacitance, and the transformer is intended to match two paralleled 1.5K output resistances to the 50 ohm load. Therefore

$$n = \sqrt{\frac{750}{50}} = 3.9{:}1$$

Actually, the best ratio was empirically determined to be 8:3. This is due to the variation from the small signal characteristics due to the high

(Continued on page 58)

PATENT REVIEW*

Of Semiconductor Devices, Fabrication Techniques and Processes, and Circuits and Applications

Compiled by SIDNEY MARSHALL

The abstracts appearing in this issue cover the inventions relevant to semiconductors from Feb. 11, 1958 to Mar. 18, 1958. In subsequent issues, patents issued from Feb. 11, 1958 to date will be presented in a similar manner. After bringing these abstracts up to date, PATENT REVIEW will appear periodically, the treatment given to each item being more detailed.

February 11, 1958

2,823,368 Data Storage Matrix—R. W. Avery. Assignee: International Business Machines Corporation. A matrix arrangement of condenser storage elements in which alternate elements are connected to common lines over which data may be read and entered, said adjacent elements allowing data to be simultaneously read from then and entered into them.

2,823,369 Condenser Storage Regeneration System—R. L. Haug, C. W. Allen. Assignee: International Business Machine Corporation. The method and apparatus for regenerating an initial condition of charge on a condenser in order that said condenser remain in a charged or uncharged state for an appreciable length of time.

February 18, 1958

2,823,983 Process For The Production of Metallic Silicon—M. J. Udy. Assignee: Strategic-Udy Metallurgical and Chemical Processes Ltd. A continuous process for the production of silicon that encompasses the use of an electric arc furnace.

2,824,030 Method of Preparing Semiconductor Materials—J. W. Rutter, W. A. Tiller. Assignee: Canadian Patents and Development Ltd. A crystal is produced by melting a semiconductor body containing two significant impurities having different distribution coefficients, and applying a temperature gradient to a part of the length of the melt in order to cause solidification of said part and therefor cause successive predominance of each of said impurities to occur within the solid.

2,824,170 Semiconductor Signal Processing Circuits—H C Goodrich. Assignee: Radio Corporation of America. A television signal separator circuit for separating synchronizing signal information from an applied video input signal.

2,824,173 Transistor Selective Ringing, Dialing And Party Identification Circuit—L. A. Meacham. Assignee: Bell Telephone Laboratories. A subscriber set for carrying out the signalling functions of ringing, dialing, and party identification in a multiparty telephone system.

2,824,174 Selective Ringing Circuit Using A Transistor—E. W. Holman. Assignee: Bell Telephone Laboratories. A selective ringing circuit for a multiparty telephone system in which signaling and ringing power at suitable potentials is supplied from a central office.

2,824,175 Selective Ringing Circuits—L. A. Meacham, F. West. Assignee: Bell Telephone Laboratories. In a station set, a ringing circuit, a filter network and signal amplifying and transducing means connected thereto, said filter network being responsive to ringing signals of a predetermined frequency, and means for limiting the amplitude of the signal applied to the filter network.

2,824,177 Hearing Aid Amplifier—S. T. Tado. Assignee: Martin Hearing Aid Co. An amplifier for hearing aids having at least two transformer coupled transistor stages.

2,824,222 Digit Storage Circuit—W. M. Furlow, Jr. Assignee: United States of America (Navy Dept.) A lunary digit storage circuit which includes a cathode coupled multivibrator which remains in an unstable state for a relatively long period but which responds to introduced pulses in short periods of time.

2,824,268 Semiconductive Device— N. H. Odell. Assignee: General Dynamics Corp. A semiconductor device consisting of a body of semiconductive material, a first area-contact electrode, a second point-contact electrode, and a third line-contact electrode.

2,824,269 Silicon Translating Devices And Silicon Alloys Therefor—R. S. Ohl. Assignee: Bell Telephone Laboratories. A ternary alloy of silicon comprising about .02 weight percent of boron, about .13 weight percent of gallium, and the remainder high purity silicon.

2,824,276 Current Control Regulator—H. Stump. Assignee: Hughes Aircraft Co. In a self-regulating current source, means for automatically controlling the current flowing through the current generator, to maintain the current flowing through a load impedance at a predetermined level irrespective of changes of the impedance of said load impedance device.

2,824,283 Corrosion Meter—L. E. Elison. Assignee: The Pure Oil Company. A wheatstone bridge circuit for detecting and measuring the corrosion induced dimensional changes of a metal specimen which constitutes one of the arms of the bridge.

2,824,287 Signal Amplitude to Pulse Duration Converter—J. S. Green, R. G. Semrad, A. H. Nichols. Assignee: Hughes Aircraft Company. A device for developing an output pulse whose duration is directly proportional to the amplitude of an applied input signal.

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2,824,697 Control Apparatus—G. F. Pittman, Jr., R. O. Decker, R. L. Bright. Assignee: Westinghouse Electric Corp. Means for sensing time of arrival of the saturation point of a magnetic core, said saturation being caused by a predetermined number of input pulses, and means for resetting said core to saturation in the other direction.

2,824,698 Recycling Pulse Counter—R. I. van Nice, R. C. Lyman. Assignee: Westinghouse Electric Corp. A counting circuit comprising a plurality of tandem-connected counter stages, saturable core means for each stage, control means for establishing an initial flux level in said saturable core, and means to selectively control the number of input pulses to a stage necessary to cause an output pulse.

2,824,964 Semiconductor Oscillator Circuits—Ho Yin. Assignee: Radio Corporation of America. A high frequency sine wave oscillator comprising a semiconductive device, means for providing negative resistance characteristics in the collector circuit of said device, a frequency determining circuit, and a coupling capacitor between the emitter and the junction of the collector electrode and the frequency determining circuit.

2,824,977 Semiconductor Devices And Systems—J. I. Pankove. Assignee: Radio Corporation of America. A device consisting of a ring shaped semiconductor body providing a closed loop path for current flow, a base electrode in contact with said body, and a single emitter and collector electrode in contact with said body.

2,825,014 Semiconductor Device—T. W. Willemse. Assignee: North American Phillips Company, Inc. A transistor or crystal diode fabrication technique that provides an electrode and contact system that is electrically insulated from the housing of the device and also provides a means for eliminating any adverse reaction between the solder and flux used and the semiconductor body.

2,825,015 Contacting Arrongement For Semiconductor Device And Method For The Fabrication Thereof—J. W. Stineman, Jr., S. A. Robinson. Assignee: Philco Corporation. Apparatus for providing gentle yet stable spring contact to a predetermined small region of an integral semiconductive structure.

*Source: Official Gazette of the U. S. Patent Office and Specifications and Drawings of Patents Issued by the U. S. Patent Office.

March 4, 1958
2,825,549 Mold For Semiconductor Ingots—G. C. Florio. Assignee: International Telephone & Telegraph Corp. A mold for forming a plurality of semiconductor ingots, said mold having a plurality of similar sections with bottom portions that are inclined to the horizontal.

2,825,667 Method of Making Surface Alloyed Semiconductor Devices—C. W. Mueller. Assignee: Radio Corporation of America. The method includes attaching a body of a conductivity-type-determining electrode material to the surface of a crystalline semiconductor by melting said body onto said semiconductor and heat treating the joined bodies in an oxidizing atmosphere in order to form a rectifying barrier in said semiconductor.

2,825,668 Process of Making A Plate Oxide Rectifier—R. B. Howes, R. F. Gill, Jr. Assignee: Jack F. Coons, Jr. A process consisting of exposing a surface of titanium to a stream of pure superheated steam moving at a velocity of between 65 and 150 feet per minute, and having a temperature between 1400°F and 1550°F, in order to form an oxide film upon said surface.

2,825,806 Transistor Trigger Circuit With Tube Controlling Emitter—C. A. Bergfors. Assignee: International Business Machines Corporation. A scaling trigger circuit having a transistor and an electron tube, and signal input means between the control grid and the base electrode for transmitting thereto a series of signal impulses.

2,825,810 Semiconductor Signal Translating Circuits—H. M. Zeidler. Assignee: Radio Corporation of America. A transistor having diode means which is forward biased in response to a developed oscillator signal to reduce the base circuit impedance and limit the amplitude of the developed oscillator signal.

2,825,813 Temperature Compensated Transistor Oscillator Circuit—J. G. Sperling. Assignee: Emerson Radio and Phonograph Corp. A transistor oscillator circuit having crystal-provided frequency stability.

2,825,821 Latch Circuit—J. C. Logue. Assignee: International Business Machines Corporation. A transistorized latch or shiftable bistable input circuit.

2,825,822 Transistor Switching Circuits—C. Huang. Assignee: Sylvania Electric Products, Inc. A bistable network comprising a field effect transistor having source and drain contacts at the output circuit, including a voltage source, and connecting the source and the drain; an input circuit one branch of which contains a voltage source and an impedance, and means to limit the negative swing of the input voltage to a defined range.

2,825,856 Sealed Semiconductor Devices—P. E. Gates. Assignee: Sylvania Electric Products, Inc. A device with an enclosing envelope comprising a fusible body portion heat sealed to a fusible closure portion, and a conductive metal element lying in the zone of the seal joining the portions, said elements being sealed to both portions.

2,825,857 Contact Structure—A. Salecker. Assignee: International Business Machines Corporation. A composite transistor contact structure including a sharpened contact of wire or strip material fastened to a spring member having a spring rate that can be determined independently of the wire characteristics.

2,825,858 Broad Area Resistance Body For Hall Generators—F. Kuhrt. Assignee: Siemens-Schuckertwerke Aktiengesellschaft. A broad area resistor for a Hall generator comprising a resistor body of semiconductor compound having a carrier mobility above 6000 cm^{-2}/volt sec.

March 11, 1958
2,826,635 Noise Cancelling Circuits—D. D. Holmes. Assignee: Radio Corporation of America. Junction type transistors are used in television receiver circuits to provide sync clipping action with a substantial degree of noise cancellation.

2,826,647 Transistor Tetrode Amplifier A. G. C. System—W. F. Chow. Assignee: General Electric Company. A device that minimizes the output capacitance variations of a transistor tetrode amplifier circuit during the application of an A.G.C. signal.

2,826,692 Transistor Pulse Generator—Yoto Sihvonen. Assignee: General Motors Corporation. A square wave generator.

2,826,695 Transistor Bistable Oscillator—R. L. Gray. Assignee: Burroughs Corp. A device that converts two opposite polarity *d-c* pulses into corresponding carrier signals representing oscillating and non-oscillating circuit conditions.

2,826,696 Double-Base Diode D.C.-A.C. (F.M.) Converter—J. J. Suran. Assignee: General Electric Company. A simple circuit for achieving this device.

2,826,725 P-N Junction Rectifier—W. B. Roberts. Assignee: Sarkes Tarzian, Inc. A rectifier having a base member, a layer of partially reduced TiO_2, ZrO_2, or HfO_2, a layer of *p*-type selenium or cuprous oxide, and a conductive electrode.

2,826,731 Transistor Converter—D. A. Paynter. Assignee: General Electric Co. A *d-c* to *d-c* converter that utilizes the power handling capacity of a power transistor to convert voltages that are small compared to the peak inverse voltage rating of said power transistor.

March 18, 1958
2,827,361 Removal of Dissolved Silicon Values From Germanium Solutions—Y. E. Lebendeff, W. H. Wetherhill. Assignee: American Smelting And Refining Company. A method for removing dissolved silicon values from germanium solutions by inducing a precipitating action with the aid of soluble inorganic aluminum values.

2,827,367 Etching of Semiconductor Materials—D. L. Cox. Assignee: Texas Instruments, Inc. Etching semiconductor surfaces with a solution having the following proportions: 300 ml. of concentrated HNO_3, 160 to 220 ml of 48% HF, 50 to 200 drops of 1% KI solution in distilled water.

2,827,369 Method of Separating Germanium From Primary Materials Containing Germanium And Other Less Volatile Elements—M. De Merre. Assignee: Societe Generale Metallurgique de Hoboken (Belgium). A method of achieving the separation of germanium by treating the primary material in an atmosphere of neutral or reducing gases in such a way as to prevent fusion of said material, and collecting the germanium after the volatizing process has ben completed.

2,827,401 Metal Oxide Rectifiers—R. D. Laughlin. Assignee: United States of America (Dept. of the Army). A columbium oxide rectifier suitable for use at high temperatures, in which the oxide layer is formed on a layer of columbium under the action of superheated steam at a temperature between 500°C and 650°C.

2,827,403 Method For Diffusing Active Impurities Into Semiconductor Materials—T. C. Hall, C. A. Levi. Assignee: Pacific Semiconductors, Inc. Tto achieve the diffusion of an active impurity into silicon a silicon starting crystal is placed in a quartz tube and an alkalai hydride is placed therein; the tube is evacuated and sealed off, and the temperature within the tube is raised to a point below the melting point of silicon, but above the decomposition temperature of the alkalai hydride.

2,827,427 Method of Shaping Semiconductive Bodies—J. F. Barry, N. C. Seeley. Assignee: Bell Telephone Laboratories. A method of producing a strain-free planar surface on a germanium body through the action of electrolytic cutting means.

2,827,436 Method of Improving The Minority Carrier Lifetime In A Single Crystal Silicon Body—G. Bemski. Assignee: Bell Telephone Laboratories. A method that consists of heating a single crystal silicon body to a temperature greater than 750°C while maintaining said body in contact with nickel for a period that varies inversely with the temperature, said period being three hours at 780°C and one minute at 1100°C.

2,827,568 Transistor Multivibrator—E. R. Altschul. Assignee: United States of America (Navy Dept.) A multivibrator period being three hours at 780°C and one minute at 1100°C.

2,827,570 Stabilized Magnetic Oscillator—G. E. Lynn. Assignee: United States of America (Dept. of the Air Force). A means for coupling a magnetic oscillator to a load in such a fashion that only minor frequency changes result even during periods of substantial variation in load impedance.

2,827,573 Quarter Adder—J. P. Eckert, Jr. Assignee: Sperry Rand Corp. A quarter adder circut for use in computer circuitry comprising a pair of buffed inputs coupled to one end of a load impedance and to the inputs of a gating device, the output of said device being coupled to the other end of said load impedance.

2,827,524 Multivibrators—S. Schreider. Assignee: Hoffman Electronics Corp. In a teletypwriter control circuit a short-time bistable multivibrator which is monostable in the absence of input control signals for a predetermined time.

2,827,597 Rectifying Mounting—E. Lidow. Assignee: International Rectifier Corporation. In a mounting arrangement, a crystal or metal rectifier and its connections are sealed from the atmosphere or surrounding medium by a rigid sealing means that supports the connectors.

2,927,598 Method of Encasing a Transistor and Structure Thereof—I. E. Levy, E. S. Mockus, A. B. Spyut. Assignee. Raytheon Manufacturing Company. A two-section cylindrical metal case is used to house and hermetically seal transistor components.

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An Elementary Design Discussion of Thermoelectric Generation	Appl & Indust (AIEE) Jan 1960	Elementary problems of thermoelectric generation and some of the solutions; advantages and disadvantages at the present state of the art.	E. W. Bollmeier
Application of Switching Transistors and Saturable Reactors in High-Performance Servo	Appl & Indust (AIEE) Jan 1960	The performance of instrument servos can be improved by the exclusive use of magnetic devices and transistors.	F. B. Cox P. R. Johannessen
Electrical Properties of Gold-Doped Diffused Silicon Computer Diodes	Bell Syst Tech Jl Jan 1960	Planar diffused silicon junctions with storage times of one millimicrosecond or less are readily obtained by gold doping.	A. E. Bakanowski J. H. Forster
Germanium and Silicon Liquidus Curves	Bell Syst Tech Jl Jan 1960	New measurements are reported on the solubility of germanium in liquid gallium, thallium, tin, arsenic, bismuth, cadmium and zinc; and the solubility of silicon in liquid indium, tin, lead, antimony, bismuth and zinc.	C. D. Thurmond M. Kowalchik
Solid Solubilities of Impurity Elements in Germanium and Silicon	Bell Syst Tech Jl Jan 1960	New solubility data are presented for lead-germanium, zinc-germanium, indium-germanium, antimony-silicon, gallium-silicon and aluminum-silicon systems.	F. A. Trumbore
Transistor Operation Aided by Thermoelectric Refrigeration	Brit Comm & Elecncs Jan 1960	The application of thermoelectric thermo-stats in controling the temperature of transistors in circuits sensitive to temperature changes is considered.	H. J. Goldsmid R. A. Hilbourne
Life Testing of Germanium Power Transistors	Brit Comm & Elecncs Jan 1960	A simple procedure is established which enables those transistors which are inherently unreliable to be detected and rejected.	B. J. Cooper R. E. Ireland
Sensitive Method for Measurement of Magneto Resistance Effect with Direct Currents and with Microwaves	Brit Jl Appd Phys Jan 1960	An experimental investigation is made of the magnetoresistance effect in bismuth at frequencies of 9.2 x 10^5, 1.5 x 10^9, and 1.1 x 10^9 *cps*.	D. E. Clark J. G. Assenheim
Magnetic Amplifier Circuits—A Classification of Half-Wave and Full-Wave Non-reversible and Reversible Self-Saturating Circuits	Comm & Elecncs (AIEE) Jan 1960	An orderly, critical classification of a wide variety of self-saturating, single-phase, series-control magnetic-amplifier output circuits.	D. L. McMurtrie
A Small High-Speed Transistor and Ferrite-Core Memory System	Comm & Elecncs AIEE Jan 1960	Design and operation of a 400-bit memory for use in a time-division electronic switching system.	W. L. Shafer W. N. Toy H. F. Priebe, Jr.
Design Parameters for Optimizing the Efficiency of Thermo-electric Generators Utilizing *P*-Type and *N*-Type Lead Telluride	Comm & Elecncs AIEE Jan 1960	Discussion of fundamental relationships, and thermoelectric properties of lead telluride systems.	R. W. Fritts
A Transistorized Pulse Code Repeater	Comm & Elecncs AIEE Jan 1960	Description of a transistorized amplifier or "repeater" used for the transmission of pulse code modulation (PCM) on cable.	G. R. Partridge
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Magnetic Amplifier Binary-to-Analog Conversion	Comm & Elecncs AIEE Jan 1960	A discussion of the application of magnetic amplifiers in a digital-to-analog conversion.	A. Danylchuk D. Katz
Transistorized Multi-frequency Ringing Generator	Comm & Elecncs AIEE Jan 1959	Description of a transistorized multifrequency ringing generator which may be the approach to an "idealized" source of ringing voltage.	J. F. Kostelich B. W. Howald
Trinistor Triode, Dynistor Diode Form Static Speed-Sensing Control Circuit	Elecl Des News Jan 1960	Applications note describes circuit and operation.	
Transient Junction Temperatures in Power Transistors	Elecl Engg (AIEE) Jan 1960	With reference to transistor junction temperatures for pulsed input waveforms, a simple thermal model is assumed and a heat-flow analysis using Laplace transforms is made.	W. W. Granneman J. D. Reese
P-N-P-N Four-Layer Diodes in Switching Functions	Elecl Mfg Jan 1960	Circuits analyzed as to operating characteristics are: pulse generators, amplifiers, ring counters, switches, magnet core drivers and memory selectors.	A. W. Carlson R. H. McMahon
Design Techniques for Static Inverters	Elecl Mfg Jan 1960	Article summarizes design techniques and circuitry for static inverters in general.	A. A. Sorenson
How To Control Transistorized Multivibrators	Elecnc Design Jan 1960	Designs illustrates modes of control giving reproducible results without special selection of components.	D. W. Boensel
A Transistorized Current Stabilizer for an Electromagnet	Elecnc Engg (Br) Jan 1960	By using an auxiliary electromechanical control system on the input to a stabilizer, voltage limitations of power transistors in control circuits can be overcome.	J. C. S. Richards
The Construction of Digital-Computing System from a Basic Transistor Circuit	Elecnc Engg (Br) Jan 1960	By interconnecting a number of basic circuits consisting of one transistor, one capacitor, and three transistors, a special purpose computer has been constructed.	P. L. Cloot G. E. Jackson
Analysis of the Transistor Cascode Configuration	Elecnc Engg (Br) Jan 1960	A transistor cascode amplifier does not require neutralization but has less gain than two stages. This article investigates to what extent the internal feedback and gain are reduced.	J. R. James
Logical Design of Diode-Matrices Part 2	Elecnc Equip Engg Jan 1960	Coninuation of the proceeding installation discusses the application of these matrices to signal-handling problems.	R. B. Hurley
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Microwave Switching with Computer Diodes	Electronics Jan 15 1960	Biasing techniques permit electronic switching of microwaves with small-area junction diodes.	M. Bloom
Choosing Transistors for Monostable Vibrators	Electronics Jan 22 1960	General circuit analysis is evolved and an example is presented.	J. R. Kotlarski
Report on Semiconductive Plastics	Electronics Jan 22 1960	Development of a transistor made of polyacrylonitride is reported, references are given.	M. F. Tomaino
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Gold-Copper Contacts to Silicon	Hoffman Span Jan Feb 1960	Discussion of the gold-copper system of contacts to silicon with particular reference to the process used at Hoffman.	S. L. Matlaw
Zener Voltage Regulation vs Current Change	Hoffman Span Jan Feb 1960	A graph is presented designed to aid in the calculation of the degree of regulation that is to be expected from a zener regulator.	E. F. Koshnitz
Tunnel Diodes	IRE Tr Elecnc Dev Jan 1960	Review of the properties, principle of operation, and implications of the tunnel diode.	R. N. Hall
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Some Properties of Zinc Sulfide Crystal Grown from the Melt	Jl Appd Phys Jan 1960	The density of pure melt grown crystals was found to be higher than that of natural zinc blende crystals, or crystals grown by evaporation.	A. Addamiano M. Aven
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Dislocations in Two Types of CdS Crystals	Jl Appd Phys Jan 1960	Dislocation densities in CdS crystals (types I and II) have been investigated employing chemical etching techniques.	D. C. Reynolds S. J. Czyzak
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High Temperature "Burn-In" of Silicon Diodes	Proc 6th Natl Symp Rel & Qual Cont Jan 11-13 1960	Description of a test program to determine effectiveness of high-temperature storage and time-temperature combination which will produce lowest failure rate.	D. Cowan
Correlation of Early Indications of Failures with Life Test Results in Semiconductors Devices	Proc 6th Natl Symp Rel & Qual Cont Jan 11-13 1960	Description of early failure indications and tests used in arriving at the indicated conclusions.	E. L. Silfen
Life Characteristics of Surface Barrier Transistors	Proc 6th Natl Symp Rel & Qual Cont Jan 11-13 1960	The results of the life evaluation and the formulation of methods for predicting failures are discussed in detail.	J. E. Drennan
Photoconductivity	RCA Engineer Vol 5 No 4	Tutorial presentation includes characterizing such properties as dark conductivity, spectral response, speed of response, photosensitivity and lifetime.	R. H. Bube
A Review of Parametric Diode Research	Semiconductors Prods Jan 1960	Approaches are considered for obtaining variable capacitance diodes having a high cut-off frequency. These include finding the best material using the optimum contact geometry, obtaining the best impurity doping gradient, and choosing a good package.	G. C. Messenger
60 MC I-F Amplifier Using Silicon Tetrodes	Semiconductors Prods Jan 1960	Design of a high gain, wide band, 60mc *r-f* amplifier suitable for use in radar and missile systems.	G. E. Penisten D. E. Hall
Temperautre Effects and Stability Factor	Semiconductors Prods Jan 1960	A treatment of the effects of temperature variations on transister parameters.	A. W. Carlson
Silicon Carbide and its Use in High Temperature Rectifiers	Semiconductors Prods Jan 1960	Description of early work on the preparation of single crystals of semiconductor quality, and the fabrication of grown junction rectifiers capable of operation at 500°C.	H. C. Chang
Oil-Immersed Selenium Rectifiers and Transductors for Wide-strip Tinning Lines	Siemens Review Jan 1960	Description of installation includes technological requirement, power supply, construction, circuit arrangement and control.	K. Fiss W. Kafka

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Thermoelectricity Abstracts	US Govt Res Repts Nov 13 1959 OTS $2.50 PB 151657	Accumulation of unclassified reference to the literature on thermoelectric research, development and application.	
Intrinsic-Barrier Transistor Techniques (silicon)	US Govt Res Repts Nov 13 1959 LC $4.80 PB 142754	The requirements for a 300 *mw*, 400 *mc* oscillator transistor are stated and new techniques for making the small geometry are outlined.	J. L. Buie, J. Cohen Et al
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Transistors

Type	Mfg Process†	Dissipation watts	Collector Current I_C ma	Current Transfer Ratios Parameter	Value Min	Value Max	Collector Breakdown Voltage Parameter	min	Saturation Characteristics Parameter	Ohms‡	Alpha Cutoff $f_{\alpha b}$—mc min typ
J-460	GJ	0.150	25	h_{FE}	3		BV_{CBO}	30	$V_{CE}(sat)$	1v	
J-461	GJ	0.150	25	h_{FE}	7		BV_{CBO}	30	$V_{CE}(sat)$	1v	
J-462	GJ	0.150	25	h_{FE}	14		BV_{CBO}	30	$V_{CE}(sat)$	1v	
J-463	GJ	0.150	25	h_{FE}	20		BV_{CBO}	30	$V_{CE}(sat)$	1v	
J-464	GJ	0.150	25	h_{FE}	30		BV_{CBO}	30	$V_{CE}(sat)$	1v	
J-465	GJ	0.150	25	h_{FE}	40		BV_{CBO}	30	$V_{CE}(sat)$	1v	
J-466	GJ	0.150	25	h_{FE}	50		BV_{CBO}	30	$V_{CE}(sat)$	1v	
2N243	GJ	0.750	60	h_{fb}	0.9	0.968	BV_{CBO}	60	R_{CS}	350	
2N244	GJ	0.750	60	h_{fb}	0.961	0.989	BV_{CBO}	60	R_{CS}	350	
2N1154/951	GJ	0.750	60	h_{fb}	0.9	1.0	BV_{CBO}	50	R_{CS}	300	
2N1155/952	GJ	0.750	50	h_{fb}	0.9	1.0	BV_{CBO}	80	R_{CS}	350	
2N1156/953	GJ	0.750	40	h_{fb}	0.9	1.0	BV_{CBO}	120	R_{CS}	400	
2N339	GJ	1	60	h_{fb}	0.9	0.989	BV_{CBO}	55	R_{CS}	300	
2N340	GJ	1	60	h_{fb}	0.9	0.989	BV_{CBO}	85	R_{CS}	350	
2N341	GJ	1	60	h_{fb}	0.9	0.989	BV_{CBO}	125	R_{CS}	400	
2N342	GJ	1	60	h_{fb}	0.9	0.97	BV_{CBO}	60	R_{CS}	350	
2N342A	GJ	1	60	h_{fb}	0.9	0.97	BV_{CBO}	85	R_{CS}	350	
2N342B	GJ	1	60	h_{fe}	9	32	BV_{CBO}	85	R_{CS}	200	
2N343	GJ	1	60	h_{fb}	0.966	0.989	BV_{CBO}	60	R_{CS}	350	
2N343B	GJ	1	60	h_{fe}	28	90	BV_{CBO}	65	R_{CS}	200	
2N696	M	2		h_{FE}	20	60	BV_{CBO}	60	V_{CE}	1.5v	h_{fe} = 2 @ 20 mc
2N697	M	2		h_{FE}	40	120	BV_{CBO}	60	V_{CE}	1.5v	h_{fe} = 2.5 @ 20 mc
2N730	M	1.5		h_{FE}	20	60	BV_{CBO}	60	V_{CE}	1.5v	h_{fe} = 2 @ 20 mc
2N731	M	1.5		h_{FE}	40	120	BC_{CBO}	60	V_{CE}	1.5v	h_{fe} = 2.5 @ 20 mc
2N497	M	4		h_{FE}	12	36	BV_{CBO}	60	R_{CS}	25	
2N498	M	4		h_{FE}	12	36	BV_{CBO}	100	R_{CS}	25	
2N656	M	4		h_{FE}	30	90	BV_{CBO}	60	R_{CS}	25	
2N657	M	4		h_{FE}	30	90	BV_{CBO}	100	R_{CS}	25	
J-581	GJ	0.675	50	h_{fe}	10	30	BV_{CBO}	30	R_{CS}	500	
J-582	GJ	0.675	50	h_{fe}	10	30	BV_{CBO}	60	R_{CS}	500	
J-583	GJ	0.675	50	h_{fe}	10	30	BV_{CBO}	100	R_{CS}	500	
J-584	GJ	0.675	50	h_{fe}	20	60	BV_{CBO}	30	R_{CS}	500	
J-585	GJ	0.675	50	h_{fe}	20	60	BV_{CBO}	60	R_{CS}	500	
J-586	GJ	0.675	50	h_{fe}	20	60	BV_{CBO}	100	R_{CS}	500	
J-587	GJ	0.675	50	h_{fe}	40	150	BV_{CBO}	30	R_{CS}	500	
J-588	GJ	0.675	50	h_{fe}	40	150	BV_{CBO}	60	R_{CS}	500	
J-589	GJ	0.675	50	h_{fe}	40	150	BV_{CBO}	100	R_{CS}	500	
J-594	GJ	0.675	50	h_{fe}	10		BV_{CBO}	30	R_{CS}	500	
J-595	GJ	0.675	50	h_{fe}	10		BV_{CBO}	60	R_{CS}	500	
J-596	GJ	0.675	50	h_{fe}	10		BV_{CBO}	100	R_{CS}	500	
2N1047	M	40		h_{FE}	12	36	BV_{CEX}	80	R_{CS}	15	
2N1048	M	40		h_{FE}	12	36	BV_{CEX}	120	R_{CS}	15	
2N1049	M	40		h_{FE}	30	90	BV_{CEX}	80	R_{CS}	15	
2N1050	M	40		h_{FE}	30	90	BV_{CEX}	120	R_{CS}	15	
2N389	M	85 @ 25°C 45 @ 100°C		h_{FE}	12	60	BV_{CER}	60	R_{CS}	5	
2N424	M	85 @ 25°C 45 @ 100°C		h_{FE}	12	60	BV_{CER}	80	R_{CS}	10	

	Case Type	T
Small Signal	G	2N1
	G	USI
	G	2N1
	G	JAN
	G	2N1
	G	2N1
	G	USI
	G	2N1
	I	2N3
	I	USI
	I	2N3
	I	USI
	I	2N3
	I	USI
	I	2N3
	I	USI
	I	2N3
	A	2N1
	A	2N1
	A	2N1
	A	2N1
	A	2N1
	EE	2N1
	EE	2N1
	EE	2N1
Small Signal Industrial	A	2N1
	A	2N1
	A	2N1
	A	2N1
	A	2N1
	A	2N1
	A	2N1
	A	2N1
	A	2N1
	I	J-6
	I	J-6
	I	J-6
	I	J-6
	I	J-6
	I	J-6
	I	J-6
	I	J-6
	I	J-6
Switching and High Frequency	I	2N
	I	2N
	U*	2N
	U*	2N
	U*	2N
	U*	2N
	U*	2N
	U*	2N
	U*	2N
	H	3N
	H	3N

† Manufacturing Process Key
GJ—Grown Junction
GD—Grown Diffused
M—Diffused Mesa

or
2- Meg
50

the

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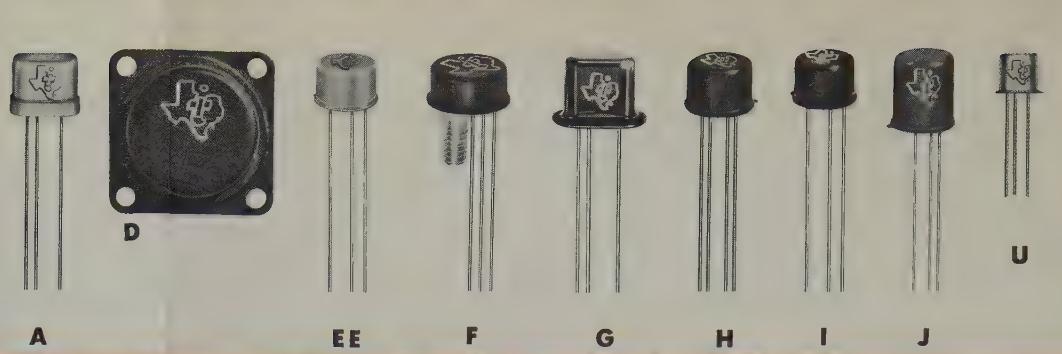
Small Signal	G	2N117	GJ	0.150	25	h_{fb}	0.9	0.953	BV_{CBO}	45	R_{CS}	200		4
	G	USN2N117	GJ	0.150	25	h_{fb}	0.9	0.953	BV_{CBO}	45	R_{CS}	200	1	
	G	2N118	GJ	0.150	25	h_{fb}	0.948	0.976	BV_{CBO}	45	R_{CS}	200		5
	G	JAN2N118	GJ	0.150	25	h_{fb}	0.948	0.976	BV_{CBO}	45	R_{CS}	200	2	
	G	2N118A	GJ	0.150	25	h_{fb}	0.948	0.989	BV_{CBO}	45	R_{CS}	200	8	
	G	2N119	GJ	0.150	25	h_{fb}	0.973	0.989	BV_{CBO}	45	R_{CS}	200		6
	G	USN2N119	GJ	0.150	25	h_{fb}	0.973	0.989	BV_{CBO}	45	R_{CS}	200	2	
	G	2N120	GJ	0.150	25	h_{fb}	0.987	0.997	BV_{CBO}	45	R_{CS}	200		7
	I	2N332	GJ	0.150	25	h_{fb}	0.9	0.953	BV_{CBO}	45	R_{CS}	200	1	6
	I	USN2N332	GJ	0.150	25	h_{fb}	0.9	0.953	BV_{CBO}	45	R_{CS}	200		4
	I	2N333	GJ	0.150	25	h_{fb}	0.948	0.976	BV_{CBO}	45	R_{CS}	200	2	8
	I	USN2N333	GJ	0.150	25	h_{fb}	0.948	0.976	BV_{CBO}	45	R_{CS}	200		5
	I	2N334	GJ	0.150	25	h_{fb}	0.948	0.989	BV_{CBO}	45	R_{CS}	200	8	10
	I	USN2N334	GJ	0.150	25	h_{fb}	0.948	0.989	BV_{CBO}	45	R_{CS}	200	8	
	I	2N335	GJ	0.150	25	h_{fb}	0.973	0.989	BV_{CBO}	45	R_{CS}	200	2	11
	I	USN2N335	GJ	0.150	25	h_{fb}	0.973	0.989	BV_{CBO}	45	R_{CS}	200		6
	I	2N336	GJ	0.150	25	h_{fb}	0.987	0.997	BV_{CBO}	45	R_{CS}	200	2	13
	A	2N1149/903	GJ	0.150	25	h_{fb}	0.9	0.953	BV_{CBO}	45	R_{CS}	200		4
	A	2N1150/904	GJ	0.150	25	h_{fb}	0.948	0.976	BV_{CBO}	45	R_{CS}	200		5
	A	2N1151/904A	GJ	0.150	25	h_{fb}	0.948	0.989	BV_{CBO}	45	R_{CS}	200	8	
	A	2N1152/905	GJ	0.150	25	h_{fb}	0.973	0.989	BV_{CBO}	45	R_{CS}	200		6
	A	2N1153/910	GJ	0.150	25	h_{fb}	0.987	0.997	BV_{CBO}	45	R_{CS}	200		7
	EE	2N1564	M	0.600	50	h_{fe}	20	50	BV_{CBO}	80	V_{CE}	1v	30	40
	EE	2N1565	M	0.600	50	h_{fe}	40	100	BV_{CBO}	80	V_{CE}	1v	30	40
	EE	2N1566	M	0.600	50	h_{fe}	80	200	BV_{CBO}	80	V_{CE}	1v	30	50
Small Signal Industrial	A	2N1586/J-503	GJ	0.150	25	h_{fe}	9	27	BV_{CBO}	15	R_{CS}	300		4
	A	2N1587/J-504	GJ	0.150	25	h_{fe}	9	27	BV_{CBO}	30	R_{CS}	300		4
	A	2N1588/J-505	GJ	0.150	25	h_{fe}	9	27	BV_{CBO}	60	R_{CS}	300		4
	A	2N1589/J-506	GJ	0.150	25	h_{fe}	25	75	BV_{CBO}	15	R_{CS}	300		6
	A	2N1590/J-507	GJ	0.150	25	h_{fe}	25	75	BV_{CBO}	30	R_{CS}	300		6
	A	2N1591/J-508	GJ	0.150	25	h_{fe}	25	75	BV_{CBO}	60	R_{CS}	300		6
	A	2N1592/J-509	GJ	0.150	25	h_{fe}	70	210	BV_{CBO}	15	R_{CS}	300		7
	A	2N1593/J-510	GJ	0.150	25	h_{fe}	70	210	BV_{CBO}	30	R_{CS}	300		7
	A	2N1594/J-511	GJ	0.150	25	h_{fe}	70	210	BV_{CBO}	60	R_{CS}	300		7
	I	J-623	GJ	0.150	25	h_{fe}	9	27	BV_{CBO}	15	R_{CS}	300		4
	I	J-624	GJ	0.150	25	h_{fe}	9	27	BV_{CBO}	30	R_{CS}	300		4
	I	J-625	GJ	0.150	25	h_{fe}	9	27	BV_{CBO}	60	R_{CS}	300		4
	I	J-626	GJ	0.150	25	h_{fe}	25	75	BV_{CBO}	15	R_{CS}	300		6
	I	J-627	GJ	0.150	25	h_{fe}	25	75	BV_{CBO}	30	R_{CS}	300		6
	I	J-628	GJ	0.150	25	h_{fe}	25	75	BV_{CBO}	60	R_{CS}	300		6
	I	J-629	GJ	0.150	25	h_{fe}	70	210	BV_{CBO}	15	R_{CS}	300		7
	I	J-630	GJ	0.150	25	h_{fe}	70	210	BV_{CBO}	30	R_{CS}	300		7
	I	J-631	GJ	0.150	25	h_{fe}	70	210	BV_{CBO}	60	R_{CS}	300		7
Switching and High Frequency	I	2N337	GJ	0.125	20	h_{FE}	20	55	BV_{CBO}	45	R_{CS}	150	10	20
	I	2N338	GJ	0.125	20	h_{FE}	45	150	BV_{CBO}	45	R_{CS}	150	20	30
	U*	2N702	M	0.600	50	h_{FE}	20	60	BV_{CBO}	25	V_{CE}	0.5v	$f_t = 150$	
	U*	2N703	M	0.600	50	h_{FE}	40	120	BV_{CBO}	25	V_{CE}	0.5v	$f_t = 150$	
	U*	2N706	M	1.000		h_{FE}	15		BV_{CBO}	25	V_{CE}	0.6v	$h_{fe} = 2$@100mc	
	U*	2N706A	M	1.000		h_{FE}	20	60	BV_{CBO}	25	V_{CE}	0.6v	$h_{fe} = 2$@100mc	
	U*	2N753	M	1.000		h_{FE}	40	120	BV_{CBO}	25	V_{CE}	0.6v	$h_{fe} = 2$@100mc	
	U*	2N715	M	0.500		h_{FE}	10	50	BV_{CEO}	35	V_{CE}	1.2v	$f_t = 150$	
	U*	2N716	M	0.500		h_{FE}	10	50	BV_{CEO}	40	V_{CE}	1.2v	$f_t = 150$	
	H	3N34	GD	0.125	20	h_{fe}	1 @ 30 mc		BV_{CBO}	30	R_{CS}	300		100
	H	3N35	GD	0.125	20	h_{fe}	1 @ 70 mc		BV_{CBO}	30	R_{CS}	300		150

† Manufacturing Process Key
GJ—Grown Junction
GD—Grown Diffused
M—Diffused Mesa

* Collector in electrical contact with case
** Emitter in electrical contact with case
‡ Except where noted

the FIRST silicon transistor manufacturer

Silicon Transistors



	Case Type	Type	Mfg Process†	Dissipation watts	Collector Current I_C ma	Current Transfer Ratios Parameter	Value Min	Value Max	Collector Breakdown Voltage Parameter	min	Saturation Characteristics Parameter	Ohms‡	Alpha Cutoff $f_{\alpha b}$—mc min typ
NOR Logic Industrial	A	J-460	GJ	0.150	25	h_{FE}	3		BV_{CBO}	30	$V_{CE}(sat)$	1v	
	A	J-461	GJ	0.150	25	h_{FE}	7		BV_{CBO}	30	$V_{CE}(sat)$	1v	
	A	J-462	GJ	0.150	25	h_{FE}	14		BV_{CBO}	30	$V_{CE}(sat)$	1v	
	A	J-463	GJ	0.150	25	h_{FE}	20		BV_{CBO}	30	$V_{CE}(sat)$	1v	
	A	J-464	GJ	0.150	25	h_{FE}	30		BV_{CBO}	30	$V_{CE}(sat)$	1v	
	A	J-465	GJ	0.150	25	h_{FE}	40		BV_{CBO}	30	$V_{CE}(sat)$	1v	
	A	J-466	GJ	0.150	25	h_{FE}	50		BV_{CBO}	30	$V_{CE}(sat)$	1v	
Medium Power and Intermediate Power	A	2N243	GJ	0.750	60	h_{fb}	0.9	0.968	BV_{CBO}	60	R_{CS}	350	
	A	2N244	GJ	0.750	60	h_{fb}	0.961	0.989	BV_{CBO}	60	R_{CS}	350	
	A	2N1154/951	GJ	0.750	60	h_{fb}	0.9	1.0	BV_{CBO}	50	R_{CS}	300	
	A	2N1155/952	GJ	0.750	50	h_{fb}	0.9	1.0	BV_{CBO}	80	R_{CS}	350	
	A	2N1156/953	GJ	0.750	40	h_{fb}	0.9	1.0	BV_{CBO}	120	R_{CS}	400	
	J**	2N339	GJ	1	60	h_{fb}	0.9	0.989	BV_{CBO}	55	R_{CS}	300	
	J**	2N340	GJ	1	60	h_{fb}	0.9	0.989	BV_{CBO}	85	R_{CS}	350	
	J**	2N341	GJ	1	60	h_{fb}	0.9	0.989	BV_{CBO}	125	R_{CS}	400	
	J**	2N342	GJ	1	60	h_{fb}	0.9	0.97	BV_{CBO}	60	R_{CS}	350	
	J**	2N342A	GJ	1	60	h_{fb}	0.9	0.97	BV_{CBO}	85	R_{CS}	350	
	J**	2N342B	GJ	1	60	h_{fe}	9	32	BV_{CBO}	85	R_{CS}	200	
	J**	2N343	GJ	1	60	h_{fb}	0.966	0.989	BV_{CBO}	60	R_{CS}	350	
	J**	2N343B	GJ	1	60	h_{fe}	28	90	BV_{CBO}	65	R_{CS}	200	
	I	2N696	M	2		h_{FE}	20	60	BV_{CBO}	60	V_{CE}	1.5v	h_{fe} = 2 @ 20 mc
	I	2N697	M	2		h_{FE}	40	120	BV_{CBO}	60	V_{CE}	1.5v	h_{fe} = 2.5 @ 20 mc
	U	2N730	M	1.5		h_{FE}	20	60	BV_{CBO}	60	V_{CE}	1.5v	h_{fe} = 2 @ 20 mc
	U	2N731	M	1.5		h_{FE}	40	120	BC_{CBO}	60	V_{CE}	1.5v	h_{fe} = 2.5 @ 20 mc
	I*	2N497	M	4		h_{FE}	12	36	BV_{CBO}	60	R_{CS}	25	
	I*	2N498	M	4		h_{FE}	12	36	BV_{CBO}	100	R_{CS}	25	
	I*	2N656	M	4		h_{FE}	30	90	BV_{CBO}	60	R_{CS}	25	
	I*	2N657	M	4		h_{FE}	30	90	BV_{CBO}	100	R_{CS}	25	
Medium Power Industrial	A	J-581	GJ	0.675	50	h_{fe}	10	30	BV_{CBO}	30	R_{CS}	500	
	A	J-582	GJ	0.675	50	h_{fe}	10	30	BV_{CBO}	60	R_{CS}	500	
	A	J-583	GJ	0.675	50	h_{fe}	10	30	BV_{CBO}	100	R_{CS}	500	
	A	J-584	GJ	0.675	50	h_{fe}	20	60	BV_{CBO}	30	R_{CS}	500	
	A	J-585	GJ	0.675	50	h_{fe}	20	60	BV_{CBO}	60	R_{CS}	500	
	A	J-586	GJ	0.675	50	h_{fe}	20	60	BV_{CBO}	100	R_{CS}	500	
	A	J-587	GJ	0.675	50	h_{fe}	40	150	BV_{CBO}	30	R_{CS}	500	
	A	J-588	GJ	0.675	50	h_{fe}	40	150	BV_{CBO}	60	R_{CS}	500	
	A	J-589	GJ	0.675	50	h_{fe}	40	150	BV_{CBO}	100	R_{CS}	500	
	A	J-594	GJ	0.675	50	h_{fe}	10		BV_{CBO}	30	R_{CS}	500	
	A	J-595	GJ	0.675	50	h_{fe}	10		BV_{CBO}	60	R_{CS}	500	
	A	J-596	GJ	0.675	50	h_{fe}	10		BV_{CBO}	100	R_{CS}	500	
Power	F*	2N1047	M	40		h_{FE}	12	36	BV_{CEX}	80	R_{CS}	15	
	F*	2N1048	M	40		h_{FE}	12	36	BV_{CEX}	120	R_{CS}	15	
	F*	2N1049	M	40		h_{FE}	30	90	BV_{CEX}	80	R_{CS}	15	
	F*	2N1050	M	40		h_{FE}	30	90	BV_{CEX}	120	R_{CS}	15	
	D*	2N389	M	85 @ 25°C 45 @ 100°C		h_{FE}	12	60	BV_{CER}	60	R_{CS}	5	
	D*	2N424	M	85 @ 25°C 45 @ 100°C		h_{FE}	12	60	BV_{CER}	80	R_{CS}	10	

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
POST OFFICE BOX 312
13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

CHARACTERISTICS CHART of NEW TRANSISTORS

Announced Between March 1, 1960 to April 30, 1960

MANUFACTURERS (In Order of Code Letters)

ARA— Advanced Research Associates, Inc.
AEG— Allgemeine Elecktricitats-gesellschaft
AMP— Amperex Electronic Corp.
AEIE— Associated Electrical Industries Ediswan Div, Enfield, Middlesex, England
AEIL— Associated Electrical Industries Export, Carholme Road, Lincoln, England
BEN— Bendix Corp.
BOG— Bogue Electric Mfg. Co.
CBS— CBS Electronics
CRY— Crystalonics, Inc.
CSF— Compagnie Generale
CTP— Clevite Transistor Products, Inc.
DEL— Delco Radio Div., General Motors Corp.
FSC— Fairchild Semiconductors Corp.
FTHF— French Thomson-Houston Semiconductor Dept.
GECB— General Electric Co., Ltd.
GE— General Electric Co.
GEM— Great Eastern Mfg. Co.
GTC— General Transistor Corp.
HSD— Hoffman Semiconductor Div.
HUG— Hughes Aircraft Co.
HIVB— Hivac Ltd.
IND— Industro Transistor Corp.
KOKJ— Kobe Kogyo Corp., Hyogo-ku, Kobe, Japan
LCTF— Labortoire Central de Telecommunications
MIFI— Microfarad (Italy)
MIN— Minneapolis-Honeywell Regulator Co.
MOT— Motorola, Inc.
MUL— Mullard Ltd.
NAC— National Semiconductor Corp.
NTLB— Newmarket Transistors Ltd.
PSI— Pacific Semiconductors, Inc.
PHI— Philco Corp., Landsdale Tube Co.
RAY— Raytheon Co.
RCA— Radio Corp. of America, Semiconductor Div.
RADF— La Radiotechnique, Div. Tubes Electroniques, 130 Ave., Ledru Rollin, Paris lle, France
RHE— Rheem Semiconductor Corp.
ROSG— Dr. ing. Rudolph Rost, Ubbenstrasse 21, Hannover 1, Germany
SIE— Siemens & Halske Aktiengesellschaft
SIL— Silicon Transistor Corp.
SONY— Sony Corp.
SPE— Sperry Gyroscope Co.
SPR— Sprague Electric Co.
SYL— Sylvania Electric Products Inc.
STCB— Standard Telephone & Cables, Ltd.
TKAD—Suddeutsche Telefon-Apparate-, Kabel und Drahtwerke
TOSJ— Tokyo Shibaura Electric Co., 1 Komukaitoshiba Cho, Kawasaki, Japan
TRA— Transitron Electronic Corp.
TFKG— Telefunken Ltd.
TI— Texas Instruments Inc.
TIIB— Texas Instruments Ltd.
TUN— Tung-Sol Electric, Inc.
UST— U. S. Transistor Corp.
WEC— Western Electric Co., Inc.
WEST— Westinghouse Electric Corp.

TYPE NO.	USE (See Code Below)	TYPE (See Code Below)	MAT	Max. Ratings @ 25° C: P_c (mw)	DERATING °C/W	V_{CB}	V_{CE}	Typical Characteristics: $f_{\alpha B}$ (mc)	Gain: PARAMETER and (condition)	VALUE	MFR. See code at start of charts
2N78A	1	NPNG	Ge	65		20		9.0			GE
2N105A	2	D	Si	5000	35	125	125	4.0	h_{FE}: 200ma	45	TRA
2N257B	3	PNPA	Ge		1.5	40			PG at 2.0A	35db	CTP
2N257G	3	PNPA	Ge		1.5	40			PG at 2.0A	37db	CTP
2N257W	3	PNPA	Ge		1.5	40			PG at 2.0A	33db	CTP
2N339A	2	D	Si	1000	175	55	55		h_{fe}: 1.0ma	40	TRA
2N340A	2	D	Si	1000	175	85	85		h_{fe}: 1.0ma	40	TRA
2N341A	2	D	Si	1000	175	125	125		h_{fe}: 1.0ma	40	TRA
2N342B	3	G	Si	1000	125	85	85	6.0	h_{fe}:I_e-5.0ma	9-32	TI
2N343B	3	G	Si	1000	125	65	65	6.0	h_{fe}:I_e-5.0ma	28-90	TI
2N377A	5∅	NPNA	Ge	150	500	40	40	6.0	h_{FE}:I_C-200ma	20min	SYL
2N385A	5∅	NPNA	Ge	150	500	40	40	9.0	h_{FE}:I_C-200ma	20min	SYL
2N388A	5∅	NPNA	Ge	150	500	40	40	12	h_{FE}:I_C-200ma	30min	SYL
2N706A	5	O	Si	1000	150	25	15	400	h_{FE}:I_C- 10ma	20-60	TI
2N711	5	O	Ge	300	.25	12	12	300			TI

NOTATIONS

Under Use

1- Low power a-f equal to or less than 50 mw
2- Medium power a-f 50 mw and equal to or less than 500 mw
3- Power 500 mw
4- r-f/i-f
5- Switching and Computer
6- Low Noise
7- Photo
8- Mixer
9- Local Oscillator
∅ - Revised Spec.
10- Chopper
11- Matched Pair

Under Type

A- Alloyed
D- Diffused or Drift
F- Fused
G- Grown
H- Hook Collector
M- Microalloy
Me- Mesa
O - Other
S - Surface Barrier
UNI- Unijunction Transistor
Y - Symmetrical
I - Tetrode

Under Gain Value

∅ – Pulsed

Under fab

* Maximum Frequency
# Figure of Merit
Δ f_e
∅ Minimum
F_T Gain Bandwidth Product $h_{fe} \times f_{hfe}$

Under Derating

∅ – Infinite heat sink

CHARACTERISTICS CHART of NEW TRANSISTORS

TYPE NO.	USE (See Code Below)	TYPE (See Code Below)	MAT	Max. Ratings @ 25° C: P_C (mw)	DERATING °C/W	V_{CB}	V_{CE}	Typical Characteristics: $f_{\alpha\beta}$ (mc)	Gain: PARAMETER and (condition)	Gain: VALUE	MFR. See code at end of chart
2N719	5	NPND	Si	1.5WØ	100	120	80	90†	h_{FE}:I_C-150ma	30	FSC
2N720	5	NPND	Si	1.5WØ	100	120	80	120†	h_{FE}:I_C-150ma	65	FSC
2N730	3	D	Si	1500	100	60	40	70	h_{FE}:I_C-150ma	20-60	TI
2N731	3	D	Si	1500	100	60	40	90	h_{FE}:I_C-150ma	40-120	TI
2N742	2	NPNMe	Si	300			60	50	h_{fe}:	80	NAC
2N752	2	NPNMe	Si	300		85	45	200†	h_{FE}:	200	NAC
2N753	5	O	Si	1000	150	25	15	400	h_{FE}:I_C- 10ma	40-120	TI
2N1046	3	AD	Ge	30W	2.5	100	50	33	h_{FE}:I_C-.50A	40	TI
2N1046A	3	AD	Ge	30W	2.5	130	50	33	h_{FE}:I_C-4.0A	20	TI
2N1046B	3	AD	Ge	30W	2.5	130	50	33	h_{FE}:I_C- 10A	10	TI
2N1055	2	D	Si	3000	58.3	125	125	4.0	h_{FE}: 50ma	45	TRA
2N1210	3	D	Si	60W	2.5	60	60	15	h_{FE}:I_C-2.0A	35	TRA
2N1211	3	D	Si	60W	2.5	80	80	15	h_{FE}:I_C-2.0A	35	TRA
2N1252	3	D	Si	2000	75	30	20	70	h_{FE}:I_C-150ma	15-45	TI
2N1617	3	D	Si	60W	2.5	80	80	15	h_{FE}:I_C-2.0A	35	TRA
2N1618	3	D	Si	60W	2.5	100	100	15	h_{FE}:I_C-2.0A	35	TRA
2N1620	3	D	Si	60W	2.5	100	100	15	h_{FE}:I_C-2.0A	35	TRA
2N1261	3Ø	PNPA	Ge	32	2.2	80	45	.20	h_{FE}:I_C-2.0A	30	MIN
2N1262	3Ø	PNPA	Ge	32	2.2	80	45	.20	h_{FE}:I_C-2.0A	43	MIN
2N1263	3Ø	PNPA	Ge	32	2.2	80	45	.20	h_{FE}:I_C-2.0A	64	MIN
2N1288	2,5	NPN	Ge	75		10		60	h_{FE}:	100	GE
2N1289	2,5	NPN	Ge	75		15		60	h_{FE}:	100	GE
2N1384	5	PNPD	Ge	240		30	30	35	h_{FE}:I_C-.20A	50	RCA
2N1420	5	NPND	Si	2WØ	75	60	30	130†	h_{FE}:I_C-150ma	130	FSC
2N1453	3	PNPA	Ge		1.5	30	25		h_{FE}:I_C-1.0A	65	CBS
2N1454	3	PNPA	Ge		1.5	30	25		h_{FE}:I_C-1.0A	110	CBS
2N1455	3	PNPA	Ge		1.5	60	50		h_{FE}:I_C-1.0A	65	CBS
2N1456	3	PNPA	Ge		1.5	60	50		h_{FE}:I_C-1.0A	110	CBS
2N1457	3	PNPA	Ge		1.5	80	65		h_{FE}:I_C-1.0A	65	CBS
2N1458	3	PNPA	Ge		1.5	80	65		h_{FE}:I_C-1.0A	110	CBS
2N1461	3	PNPA	Ge		1.5	30	25		h_{FE}:I_C-1.0A	65	CBS
2N1462	3	PNPA	Ge		1.5	30	25		h_{FE}:I_C-1.0A	110	CBS
2N1463	3	PNPA	Ge		1.5	60	50		h_{FE}:I_C-1.0A	65	CBS
2N1464	3	PNPA	Ge		1.5	60	50		h_{FE}:I_C-1.0A	110	CBS
2N1465	3	PNPA	Ge		3.0	120	70	150K	h_{FE}:I_C-1.0A	20min	CBS
2N1466	3	PNPA	Ge		3.0	120	70	150K	h_{FE}:I_C-1.0A	20min	CBS
2N1491	4	NPND	Si	500	50	30	30	250	h_{fe}:I_C-15ma	50	RCA
2N1492	4	NPND	Si	500	50	60	60	275	h_{fe}:I_C-15ma	50	RCA
2N1493	4	NPND	Si	500	50	100	100	300	h_{fe}:I_C-15ma	50	RCA
2N1501	3	PNPA	Ge	32	2.2	60	40	.20	h_{FE}:I_C-2.0A	45	MIN
2N1502	3	PNPA	Ge	32	2.2	40	40	.20	h_{FE}:I_C-2.0A	45	MIN
2N1504	3	PNPA	Ge		3.0	80	60	150K	h_{FE}:I_C-1.0A	21min	CBS
2N1507	3	NPNMe	Si	600		60	30	50†	h_{fe}:	35	NAC
2N1511	3	NPND	Si	60W	2.5	60	40	1.0	h_{FE}:I_C-1.5A	50	RCA
2N1512	3	NPND	Si	60W	2.5	100	55	1.0	h_{FE}:I_C-1.5A	50	RCA
2N1513	3	NPND	Si	60W	2.5	60	40	1.0	h_{FE}:I_C-1.5A	75	RCA
2N1514	3	NPND	Si	60W	2.5	100	55	1.0	h_{FE}:I_C-1.5A	75	RCA
2N1524	4	PNPD	Ge	80	400	24		33	h_{fe}:I_C-1.0ma	60	RCA
2N1525	4	PNPD	Ge	80	400	24		33	h_{fe}:I_C-1.0ma	60	RCA
2N1526	4	PNPD	Ge	80	400	24		33	h_{fe}:I_C-1.0ma	130	RCA
2N1527	4	PNPD	Ge	80	400	24		33	h_{fe}:I_C-1.0ma	130	RCA
2N1564	2	D	Si	1000	150	80	60	40	h_{fe}:I_e-5.0ma	20-50	TI,NAC
2N1565	2	D	Si	1000	150	80	60	40	h_{fe}:I_e-5.0ma	40-100	TI,NAC
2N1566	2	D	Si	1000	150	80	60	50	h_{fe}:I_e-5.0ma	80-200	TI,NAC
2N1605	5	NPNA	Ge	150	500	25	24	12	h_{FE}:I_C- 20ma	40min	SYL

TYPE NO.	USE (See Code Below)	TYPE (See Code Below)	MAT	Max. Ratings @ 25° C				Typical Characteristics			MFR. See code at start of charts
				P_c (mw)	DERATING °C/W	V_{CB}	V_{CE}	$f_{\alpha\beta}$ (mc)	Gain PARAMETER and (condition)	Gain VALUE	
2N1613	5	NPND	Si	3WØ	58.3	75	40	90†	h_{FE}: I_C-150ma	50	FSC
2N1614	1	A	Ge	240		65		.50Ø	h_{FE}:	32	GE
2N1616	3	D	Si	60W	2.5	60	60	15	h_{FE}: I_C-2.0A	35	TRA
2N1624	2,5	NPNA	Ge	150	500	25			h_{FE}: I_C- 30ma	120	GTC
2N1631	4	PNPD	Ge	80	400	34		45	h_{fe}: I_c-1.0ma	80	RCA
2N1632	4	PNPD	Ge	80	400	34		45	h_{fe}: I_c-1.0ma	80	RCA
2N1633	4	PNPD	Ge	80	400	34		40	h_{fe}: I_c-1.0ma	75	RCA
2N1634	4	PNPD	Ge	80	400	34		40	h_{fe}: I_c-1.0ma	75	RCA
2N1635	4	PNPD	Ge	80	400	34		45	h_{fe}: I_c-1.0ma	75	RCA
2N1636	4	PNPD	Ge	80	400	34		45	h_{fe}: I_c-1.0ma	75	RCA
2N1637	4	PNPD	Ge	80	400	34		45	h_{fe}: I_c-1.0ma	80	RCA
2N1638	4	PNPD	Ge	80	400	34		40	h_{fe}: I_c-1.0ma	75	RCA
2N1639	4	PNPD	Ge	80	400	34		45	h_{fe}: I_c-1.0ma	75	RCA
2N1640	2	PNPY	Si	250	540	30		.40	h_{FE}: I_B-.10ma	9	CRY
2N1641	2	PNPY	Si	250	540	30		.80	h_{FE}: I_B-.10ma	13	CRY
2N1642	2	PNPY	Si	250	540	30		1.2	h_{FE}: I_B-.10ma	19	CRY
2N1643	2	PNPA	Si	250	540	25		.70	h_{FE}: I_B-.10ma	16	CRY
2N1651	3,5	PNPDA	Ge	65	1.3	60	60	2.5	h_{FE}: 25A	45	BEN
2N1652	3,5	PNPDA	Ge	65	1.3	100	100	2.5	h_{FE}: 25A	45	BEN
2N1653	3,5	PNPDA	Ge	65	1.3	120	120	2.5	h_{FE}: 25A	45	BEN
2N1663	2,5	SAD	Si	100	1250	20	20	150†	h_{FE}:	50	PHI
2N1666	5	PNPA	Ge				60	.20	h_{fe}: I_e-1.0A	32	AMP
2N1667	5	PNPA	Ge				32	.20	h_{fe}: I_e-1.0A	90	AMP
2N1668	5	PNPA	Ge				32	.20	h_{fe}: I_e-1.0A	50	AMP
2N1669	5	PNPA	Ge				32	.20	h_{fe}: I_e-1.0A	70	AMP
CDT1310	3,5	PNPA	Ge		1.5	40	35		h_{FE}: I_C-2.0A	80	CTP
CDT1311	3,5	PNPA	Ge		1.5	60	50		h_{FE}: I_C-2.0A	80	CTP
CDT1312	3,5	PNPA	Ge		1.5	80	65		h_{FE}: I_C-2.0A	80	CTP
CDT1313	3,5	PNPA	Ge		1.5	100	75		h_{FE}: I_C-2.0A	80	CTP
CDT1315	3,5	PNPA	Ge		1.5	100	75		h_{FE}: I_C-5.0A	105	CTP
CDT1319	3,5	PNPA	Ge		1.5	40	35		h_{FE}: I_C-2.0A	40	CTP
CDT1320	3,5	PNPA	Ge		1.5	60	50		h_{FE}: I_C-2.0A	40	CTP
CDT1321	3,5	PNPA	Ge		1.5	80	65		h_{FE}: I_C-2.0A	40	CTP
CDT1322	3,5	PNPA	Ge		1.5	100	75		h_{FE}: I_C-2.0A	40	CTP
CST1739	3	PNPA	Ge		2.5	40	35		PG at 2.0W	33	CTP
CST1740	3	PNPA	Ge		2.5	40	35		PG at 2.0W	30	CTP
CST1741	3	PNPA	Ge		2.5	40	35		PG at 2.0W	33	CTP
CST1742	3	PNPA	Ge		2.5	40	35		PG at 2.0W	35	CTP
CST1743	3	PNPA	Ge		2.5	40	35		PG at 2.0W	37	CTP
CST1744	3	PNPA	Ge		2.5	80	65		PG at 2.0W	33	CTP
CST1745	3	PNPA	Ge		2.5	80	65		PG at 2.0W	30	CTP
CST1746	3	PNPA	Ge		2.5	80	65		PG at 2.0W	35	CTP
CTP1265	3,5	PNPA	Ge		1.5	60	50		h_{FE}: I_C-5.0A	53	CTP
CTP1266	3,5	PNPA	Ge		1.5	60	50		h_{FE}: I_C-5.0A	105	CTP
CTP1296	3,5	PNPA	Ge		1.5	80	65		h_{FE}: I_C-5.0A	53	CTP

NOTATIONS

Under Use

1– Low power a-f equal to or less than 50 mw
2– Medium power a-f 50 mw and equal to or less than 500 mw
3– Power 500 mw
4– r-f/i-f
5– Switching and Computer
6– Low Noise
7– Photo
8– Mixer
9– Local Oscillator
Ø– Revised Spec.
10– Chopper
11– Matched Pair

Under Type

A– Alloyed
D– Diffused or Drift
F– Fused
G– Grown
H– Hook Collector
M– Microalloy
Me– Mesa
O – Other
S – Surface Barrier
UNI– Unijunction Transistor
Y – Symmetrical
I – Tetrode

Under Gain Value

Ø – Pulsed

Under fab

* Maximum Frequency
† Figure of Merit
Δ f_e
Ø Minimum
F_T Gain Bandwidth Product $h_{fe} \times f_{hfe}$

Under Derating

Ø – Infinite heat sink

CHARACTERISTICS CHART of NEW TRANSISTORS

TYPE NO.	USE (See Code Below)	TYPE (See Code Below)	MAT	Max. Ratings @ 25° C: P_C (mw)	Max. Ratings @ 25° C: DERATING °C/W	Max. Ratings @ 25° C: V_{CB}	Max. Ratings @ 25° C: V_{CE}	Typical Characteristics: $f_{\alpha/\beta}$ (mc)	Typical Characteristics: Gain: PARAMETER and (condition)	Typical Characteristics: Gain: VALUE	MFR. See code at start of charts
CTP1297	3,5	PNPA	Ge		1.5	80	65		h_{FE}:I_C-5.0A	105	CTP
CTP1306	3,5	PNPA	Ge		1.5	40	35		h_{FE}:I_C-5.0A	53	CTP
CTP1307	3,5	PNPA	Ge		1.5	40	35		h_{FE}:I_C-5.0A	105	CTP
CTP1314	3,5	PNPA	Ge		1.5	100	75		h_{FE}:I_C-5.0A	53	CTP
CTP1500	3,5	PNPA	Ge		1.0	100	80		h_{FE}:I_C-5.0A	53	CTP
CTP1503	3,5	PNPA	Ge		1.0	80	70		h_{FE}:I_C-5.0A	53	CTP
CTP1504	3,5	PNPA	Ge		1.0	60	50		h_{FE}:I_C-5.0A	53	CTP
CTP1508	3,5	PNPA	Ge		1.0	40	40		h_{FE}:I_C-5.0A	53	CTP
CTP1544	3,5	PNPA	Ge		1.0	60	40		h_{FE}:I_C- 25A	50	CTP
CTP1545	3,5	PNPA	Ge		1.0	80	60		h_{FE}:I_C- 25A	50	CTP
CTP1552	3,5	PNPA	Ge		1.0	40	30		h_{FE}:I_C- 25A	50	CTP
CTP1553	3,5	PNPA	Ge		1.0	100	75		h_{FE}:I_C- 25A	50	CTP
CTP3500	3,5	PNPA	Ge		1.0	100	80		h_{FE}:I_C-5.0A	53	CTP
CTP3503	3,5	PNPA	Ge		1.0	80	70		h_{FE}:I_C-5.0A	53	CTP
CTP3504	3,5	PNPA	Ge		1.0	60	50		h_{FE}:I_C-5.0A	53	CTP
CTP3508	3,5	PNPA	Ge		1.0	40	40		h_{FE}:I_C-5.0A	53	CTP
CTP3544	3,5	PNPA	Ge		1.0	60	40		h_{FE}:I_C- 25A	50	CTP
CTP3545	3,5	PNPA	Ge		1.0	80	60		h_{FE}:I_C- 25A	50	CTP
CTP3552	3,5	PNPA	Ge		1.0	40	30		h_{FE}:I_C- 25A	50	CTP
CTP3553	3,5	PNPA	Ge		1.0	100	75		h_{FE}:I_C- 25A	50	CTP
EW721	2	NPN	Si	250	500	45		.80	h_{fe}:I_c-1.0ma	15	GECB
EW722	2	NPN	Si	250	500	45		23	h_{fe}:I_c-1.0ma	30	GECB
EW723	2	NPN	Si	250	500	45		28	h_{fe}:I_c-1.0ma	50	GECB
GET691	2	PNPD	Ge	75	650	20		30	h_{fe}:I_c-1.0ma	60	GECB
GET692	2	PNPD	Ge	75	650	20		40	h_{fe}:I_c-1.0ma	60	GECB
GET693	2	PNPD	Ge	75	650	20		50	h_{fe}:I_c-1.0ma	60	GECB
MA1	1,4	PNPM	Ge	25		6.0	6.0	20	h_{fe}:I_c-1.0ma	40-450	SPR
MA2	1,4	PNPM	Ge	20		3.0	3.0	20	h_{fe}:I_c-1.0ma	40-450	SPR
MA28	1,4	PNPM	Ge	25		6.0	6.0	40	h_{fe}:I_c-1.0ma	20min	SPR
PT900	3,4,5	NPND	Si	125W	1.0	80	50	50	h_{FE}:I_C- 10A	10min	PSI
PT901	3,4,5	NPND	Si	125W	1.0	140	100	50	h_{FE}:I_C- 10A	10min	PSI
RT5001	5	D	Si	3000	60	60			h_{fe}:I_c-500ma	20-60	RHE
RT5002	5	D	Si	3000	60	60			h_{fe}:I_c-500ma	40-120	RHE
RT5003	5	D	Si	3000	60	100			h_{fe}:I_c-500ma	20-60	RHE
RT5004	5	D	Si	3000	60	100			h_{fe}:I_c-500ma	40-120	RHE
SO2	1,4	PNPS	Ge	15		3.0	3.0	10	h_{fe}:I_c-.50ma	10min	SPR
ST1504	4	D	Si	300		60		30	h_{FE}: 500ua	15	TRA
ST1505	4	D	Si	300		100		30	h_{FE}: 500ua	15	TRA
ST1506	5	D	Si	300		30		30	h_{FE}: 1.0ma	20	TRA
STC1101	3	D	Si	85	2.06		60	.50∅	h_{FE}: 1.5A	10-50	SIL
STC1102	3	D	Si	85	2.06		100	.50∅	h_{FE}: 1.5A	10-50	SIL
STC1103	3	D	Si	85	2.06		60	.50∅	h_{FE}: 1.5A	25-75	SIL
STC1104	3	D	Si	85	2.06		100	.50∅	h_{FE}: 1.5A	25-75	SIL
XA701	5	NPNA	Ge	120		25	15	5.0	h_{FE}:I_C- 20ma	40	AEIE
XA702	5	NPNA	Ge	120		25	15	7.0	h_{FE}:I_C- 20ma	50	AEIE
XA703	5	NPNA	Ge	120		25	12	13	h_{FE}:I_C- 20ma	70	AEIE
XS121	5	PNPAY	Ge	150	330	21	12	5.0	h_{FE}:I_C-100ma	18	AEIE

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M- Microalloy
Me- Mesa
O - Other
S - Surface Barrier
UNI- Unijunction Transistor
Y - Symmetrical
I - Tetrode

Under Gain Value

∅ - Pulsed

Under fab

* Maximum Frequency
# Figure of Merit
Δ f_e
∅ Minimum
F_T Gain Bandwidth Product $h_{fe} \times f_{hfe}$

Under Derating

∅ - Infinite heat sink

New Literature

Worklon, Inc., 1960 catalog illustrates heir line of acid and caustic resistant in-lustrial apparel. Describes latest advances n special purpose industrial apparel for oday's varied requirements. Gives lab-ratory reports on techical properties of iber used, as well as complete informa-ion on the various items of apparel and heir applications. Especially of interest o industries striving to combat dust con-amination.

Circle 115 on Reader Service Card

The new VECO data sheet, SE 102, de-cribes kits containing the items neces-ary to acquaint engineers with a variety of thermistor and varistor applications nd to assist in the solution of circuitry lesign problems. The sheet lists the con-ents of each kit as well as their electri-al characteristics. Five thermistor cir-uit design kits, two varistor circuit lesign kits, and two experimentors' kits re described in detail.

Circle 106 on Reader Service Card

Panel-mounting electronic voltmeters expressly designed for continuous moni-toring of critical parameters in systems and consoles, are described in a new folder of data sheets issued by Metronix, Inc. Single and multiple range PMEVs, both commercial and military types, are described. The folder, which discusses the reasons for the development of PMEVs, includes a tabulation that shows at a glance the principal specifications of the Metronix instruments.

Circle 113 on Reader Service Card

New improved performance character-istics for standard Type 150D hermeti-cally-sealed solid-electrolyte Sprague Tantalex capacitors are shown in the 'D' issue of Engineering Bulletin No. 3520, which replaces the earlier 'C' issue. Leakage current limits have been cut in half in the new bulletin, surge voltage ratings increased for 15, 20, and 35 volt capacitors, and new ratings have been added to the ±10% decade series in the two larger case sizes. Augmented per-formance curves for typical capacitors have been shown to help the equipment designer. In addition, the guide to ap-plication has been expanded.

Circle 121 on Reader Service Card

Radio Receptor Company (Selenium Division) has released a new catalog, EL-316, eight pages, covering all prod-uct lines of selenium diodes and recti-fiers, designed to meet applications in the electronics, entertainment and special products fields. Included in the brochure is complete technical data, circuit dia-grams, rectifier stack designs, coding systems and photos covering all standard electronic products, special UL accepted units for the entertainment industry, spe-cial mounting types, and rectifiers for printed wiring boards.

Circle 122 on Reader Service Card

Optimized Devices, Inc. has issued Bulletin TT-1, a 4 page folder describing their Automatic Transistor Test Station. Lists applications, specifications, typical operation, system description, features, module description, etc.

Circle 127 on Reader Service Card

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SEMICONDUCTOR PRODUCTS is making a new source of information available to all firms interested in being kept up to date on materials or equipment for producing semiconductor devices. If you wish to receive all new literature on silicon, germanium, chemicals, machinery, or other such materials, circle #99 on the reader-service card. Your name will be placed on a special list which will be forwarded to all such suppliers. As these suppliers have news available in their field, you'll be notified by them immediately. This service is restricted to firms manufacturing semiconductor devices or firms contemplating entering into production within 120 days.

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Industry

CONFERENCE CALENDAR

The Following August 1960 Meetings Are Scheduled:

Aug 1-3 — 4th Global Communications Symposium, Statler Hotel, Washington, D. C. Sponsored by PGCS, U.S. Signal Corps. For Information: Robert F. Brady, Office of Chief Signal Officer, U.S. Signal Corps, Pentagon, Washington, D. C.

Aug 8-12 — AIEE Pacific General Meeting, El Cortes Hotel, San Diego, Calif. For Information: R. C. Mayer & Associates, 51 E. 42nd Street, New York 17, N. Y.

Aug 18-19 — Electronic Packaging Symposium, University of Colorado, Boulder, Colo.

Aug 23-25 — Association for Computing Machinery, National Convention, Marquette University, Milwaukee, Wisc.

Aug 23-26 — WESCON, Ambassador Hotel & Memorial Sports Arena, Los Angeles, Calif. Sponsored by LA & SF Sections; WCEMA; All PG's. For Information: Richard G. Leitner, WESCON Business Office, 1435 La Cienega Blvd., Los Angeles 35, Calif.

Aug 29-31 — Conference on "Metallurgy of Elemental and Compound Semiconductors" Statler Hotel, Boston, Mass. Sponsored by the Metallurgical Society of AIME, 29 W. 39th Street, New York 18, N. Y.

Aug 29-Sept 2 — International Conference on Semiconductor Physics, Prague, Czechoslovakia.

Aug 29-Sept 3 — International Information Theory Meeting, London, England. Sponsored by PGIT, IEE. For Information: Dr. Colin Cherry, Dept. of EE, Imperial College, University of London, Exhibition Rd., London, S.W. 7, England.

Texas Instruments Incorporated announced the signing of a new agreement with International Business Machines Corporation providing for the continuing exchange of technical information pertaining to transistors and diodes for at least three more years. In addition, the exchange of technical information was redefined and broadened to include Solid Circuits. Under the agreement, each company retains the right to exchange its technical information with other organizations. This agreement replaces the one in effect between the two companies since late 1957 which was subject to termination or renewal this year.

News . . .

RESEARCH & DEVELOPMENT

A transistorized "electronic brake" for controlling the power of a nuclear chain reaction will be constructed for the Atomic Energy Commission's new Pathfinder Atomic Power Plant at Sioux Falls, S.D. Engineers of The Bendix Corporation's Cincinnati division said the unit, called a "reactor flux monitor and safety system," will automatically and continuously measure the number of neutrons, or atomic energy output, of the reactor from the start of its chain reaction through the full cycle of operations. Any time the energy output starts to exceed normal levels the system will automatically shut down the reactor in a fraction of a second, the engineers said. The Northern States Power Company, Minneapolis, will operate the Pathfinder reactor. Allis-Chalmers, Milwaukee, is the prime contractor for the project.

A research program underway at Transitron Electronic Corporation for the past year on improved photovoltaic solar energy converters has resulted in raising solar cell efficiences to 15 per cent, the company has reported. Results of the effort were described in a paper prepared by Dr. H. Gunther Rudenberg, Director of Research and Development and Dr. Brian Dale, Senior Physisist. The paper described the improvements made in high efficiency silicon solar cells under research studies sponsored by the U.S. Army Signal Corps, the Air Force Cambridge Research Center and the Advanced Research Projects Agency. The study has raised the overall conversion efficiency of the units to 15 per cent by careful design of the cell structure; has raised the output voltage of the cell, substantially lowered the series resistance, and has provided various surfaces with differing optical characteristics. A new tetrahedral surface structure, as well as clear silicon surfaces and adjustable optical coatings, were also described.

The discovery that zinc oxide and cadmium sulfide are strongly piezoelectric has been revealed by A. R. Hutson of Bell Telephone Laboratories. In order to demonstrate the pizoelectricity in zinc oxide, it first had to be "doped" with lithium to neutralize the excess conductivity which has masked the effect till now. The degree of piezoelectricity exhibited by the doped zinc oxide is about four times as great as that of quartz, while the cadmium sulfide is twice as great. Confirming measurements were made on single crystals of zinc oxide grown both by vapor techniques and from a flux. The cadmium sulfide crystals were vapor grown. The conductivity of the zinc oxide was "quenched" by diffusing lithium atoms into the material, to act as acceptors for the excess electrons which were contributing to the conductivity. When this was done, the resistivity of the material was raised from 10^3 to 10^{12} ohm-cm at room temperature. Resonance-antiresonance measurements and direct squeeze measurements were made on vapor-phase grown needles and flux-grown platelets of zinc oxide, and on the vapor-phase grown cadmium sulfide.

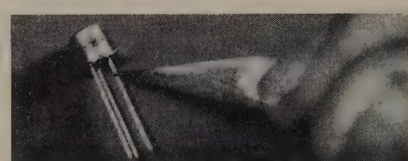
New Products

Capacitor Analyzer

Sprague has announced their Model TCA-1 Transcap Analyzer designed exclusively for safely testing low-voltage transistor circuit capacitors. Designed for 105-125 Volts a-c/60 cycle operation. Capacitance Bridge: 1 uuf to 2,000 uuf in 5 overlapping ranges; Insulation Resistance: 50 megohms to 20,000 megohms; Power Factor: 0 to 50%; Leakage Current: 0.6ua to 600ua in 7 ranges; A-C Bridge Voltage: 0.5v, Polarizing Voltage: 0 to 150v.

Circle 91 on Reader Service Card

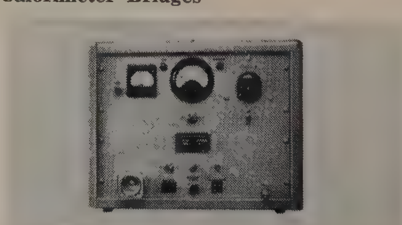
Silicon Mesa Switcher



Texas Instruments has announced an ultra-high speed *n-p-n* silicon mesa switcher 2N706A, which meets all specifications of the standard 2N706. Guaranteed features include *d-c* beta ranges of 20 to 60, lower charge storage time constant of 25 nanoseconds max, lower output capacity from 6pf to 5pf, turn-on time of 40 nanoseconds max, turn-off time of 75 nanoseconds max, minimum BV_{CEO} of 15 volts at a sustaining current of 10 mA, and maximum I_{CER} (RBE = 100K) of 10 μA at 20 volts V_{CE} (which gives a practical "switch off" test).

Circle 88 on Reader Service Card

Calorimeter Bridges



A new series of high power Calorimeter Bridges from 10 watts to 5,000 watts full scale with 2% or better accuracy and frequency range from *d-c* to 12 KMC coaxial or waveguide is announced by Electro Impulse Laboratory.

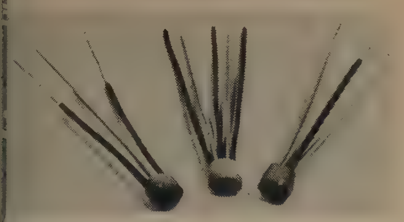
Circle 90 on Reader Service Card

Switching Devices

Transitron Electronic Corporation announces that it has added two new units to its series of Transwitch *p-n-p-n* switching devices to provide voltage ratings up to 200. Also, the company is now offering all four devices in the compact, smaller TO-13 package, as well as the TO-5 package. The Transwitch is a bistable silicon device which can be turned off with a gate current.

Circle 83 on Reader Service Card

bminiature Encapsulated Rectifiers

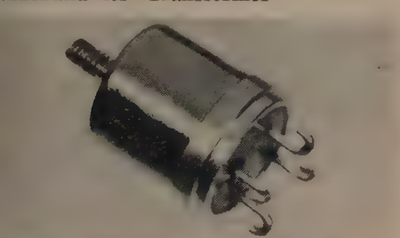


Radio Receptor Company (Selenium ivision) has developed subminiature ncapsulated rectifiers in center tap, idge and doubler assemblies. All units e designed for operation in ambient mperatures from —50C to +100C with- ut derating and are protected against mospheric conditions by the plastic ncapsulation. They will withstand peak urge currents up to 250 mils for 1 sec- nd duration and can be operated in cir- uits at frequencies up to 25 Kc.
Circle 77 on Reader Service Card

iode Recovery Plug-In Unit

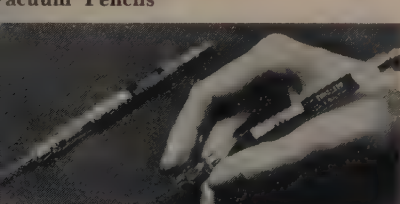
Tektronix Type S Plug-In Unit dis- ays semiconductor diode switching haracteristics on the crt of an associated scilloscope. It permits measurement of ertain diode parameters readily and eliably from the display. It allows pre- iction of diode performance in a cir- uit through analysis of the recovery and urn-on characteristics. The versatile nit can also be used to observe tran- stor junction characteristics and to easure circuit component resistance, apacitance, or inductance.
Circle 78 on Reader Service Card

Videband RF Transformer



North Hills Electronics new 1214 wide- and RF transformer covers a frequency ange of 1.5 to 130 megacycles. Imped- nce ratio is 75 ohms unbalanced to 600 hms balanced. The unit will handle 1 vatt of power. The Series 1214 units are ermetically sealed and have a single -40 stud mounting. The case is 5/8″ O.D. y 5/8″ long and is nickel-plated.
Circle 86 on Reader Service Card

Vacuum Pencils

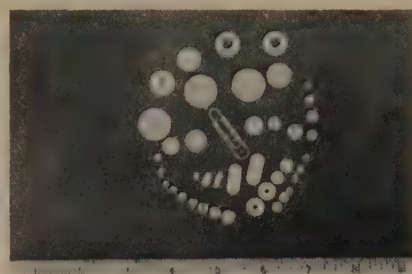


Sandland Tool and Machine Company s now manufacturing two new series of acuum pencils. The Sandland line offers choice of 24 straight and curved needle nodels with inside diameters ranging rom 0.012″, 0.018″, 0.027″ and 0.033″. The acuum pencil is gaining increased pop- larity among manufacturers of semi- onductor devices. It enables the assem- ler to quickly pick-up and deposit vafers, pellets, etc.
Circle 80 on Reader Service Card

Tunnel Diode Series

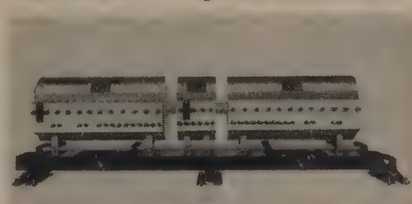
New series being introduced by the Lansdale Division of Philco are hermetically sealed germanium tunnel diodes designed for low level switching and small signal applications such as in special counting circuitry. Peak point current is closely controlled providing a peak to valley ratio of 8 to 1. Typical performance shows peak voltage of 55 millivolts and a valley voltage of 320 millivolts. Like their forerunners, the new units also exhibit low series inductance of one millimicrohenry and low series resistance of one ohm.
Circle 84 on Reader Service Card

Glass Beads



A complete line of multiform glass beads in a variety of shapes for hermetic seal header applications such as transistor bases or relay covers, is now available from Electronic-Ceramics Co. Glass beads for both Kovar and compression type hermetic seals are offered. The parts are available in all the RMA colors in a range of size from single hole beads to multi-hole ones. The beads vary in size from .050″ O.D. to .750″ O.D., with thickness between .020″ and .250″ max.
Circle 85 on Reader Service Card

Semiconductor Preparation Furnaces



Marshall Products Company has just introduced their Model 60-SC furnace apparatus for semiconductor preparation and growing single crystal materials. The apparatus consists of two or more tubular furnaces, according to the material's requirements, mounted on a common axis. This permits zone refining, directional freezing or slow crystallization, seeding, and crystal growing in the quartz work tube which runs through all furnace chambers.
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EIA-NEMA Standards For Color Coding of Semiconductor Devices (Diodes and Rectifiers)

1. TYPE NUMBERS — The JEDEC* assigned type numbers may be indicated on the semiconductor diode or rectifier by color bands coded in accordance with Table 1.

2. PREFIX IDENTIFICATION—The prefix identification consisting of a first number symbol and the letter "N" shall not be indicated in the coding.

3. BANDING SYSTEMS — The sequence number consisting of a two, three or four digit number after the letter "N" may be color coded as follows:

3.1 Two-digit sequence numbers shall consist of a first black band and the sequence number in second and third bands of the colors indicated in Table 1. If a suffix letter is required, it shall be indicated with a fourth band as indicated in Table 1.

3.2 Three-digit sequence numbers shall consist of the sequence number in first, second and third bands of the colors indicated in Table 1. If a suffix letter is required, it shall be indicated with a fourth band as indicated in Table 1.

3.3 Four-digit sequence numbers shall consist of the sequence number in four bands of the colors indicated in Table 1 with a fifth black band. If a suffix letter is required, it shall be indicated as the fifth band and shall replace the black band.

4. CATHODE IDENTIFICATION AND READING SEQUENCE

4.1 A double-width band shall be used as the first band reading from cathode to anode ends.
4.2 An alternative method is provided where equal width bands may be used. The bands shall be clearly grouped toward the cathode end, and shall be read from cathode to anode ends.
4.3 Either of the above color banding methods may be used in lieu of the cathode designating symbol or other marking.

5. COLOR BANDS

5.1 The Bands shall be circumferential and unbroken on cylindrical bodies.
5.2 The color bands shall be not less than $1/64''$ (.016) wide and separated from each other by the same minimum distance.
5.3 The sequence numbers of the type numbers and suffix letters shall be indicated by the colors in Table 1.

*Joint Electron Device Engineering Councils, sponsored by the Electronic Industries Association and the National Electrical Manufacturers Association.

TABLE 1

Number	Color	Suffix Letter
0	Black	not applicabl
1	Brown	A
2	Red	B
3	Orange	C
4	Yellow	D
5	Green	E
6	Blue	F
7	Violet	—
8	Gray	—
9	White	—

5.4 The colors used shall conform t EIA Standard GEN-101A or later issue for unmistakable readability.

6. APPENDIX — As of October 1956, the assignment of JEDEC type numbers t semiconductor diodes and rectifiers have been segregated by size.
Three digit type numbers (to and including 1N999) have been reserved fo sizes as follows:
6.1 Glass types having maximum envelope dimensions within the space cylinder with dimensions of 0.300″ length by 0.150″ diameter.
6.2 Metal and/or ceramic types having maximum envelope dimensions within the space cylinder with dimensions o 0.200″ length by 0.125″ diameter.
6.3 Four digit type numbers (1N100 and above) have been reserved fo types which exceed either of the limiting dimensions of the respective spac cylinders.

Market News

Prices

Philco has reduced the unit price of its tunnel diodes introduced last March from $10.00 to $5.00 and has introduced a new tunnel diode series. These new units are available in limited quantities at $5.00 per unit.

Fairchild Semiconductor Corp. has reduced the price of its diffused silicon mesa transistor 2N706. The price drop represents a reduction from $24 to $15 in quantities less than 100. In 100 to 999 lots the change will be from $16 to $10.

Radio Receptor Co., Inc. has available eight types of plastic encapsulated selenium diodes with peak voltages up to 400v at 3.75 ma. These are priced from 13 to 20¢ each. The firm also has available a line of encapsulated rectifiers claimed to withstand peak surge currents to 250 ma for 1 sec. and can be operated at 25 kc. Center tap units are priced from 22 to 34¢; bridge assemblies at 28¢; and doubler units from 22 to 34¢ in production quantities.

Hoffman Electronics Corporation's Semiconductor Division has announced that it is offering guaranteed 13% minimum efficiency silicon solar cells in production quantities. Solar cells with 14% efficiency also are being produced and are available in sample quantities.

Price for the 13% efficiency cells in quantites of 100 to 999 is $12.50 each. In the same quantity range, cells with minimum guaranteed efficiency of 12% are priced at $8.45 each and those of 11% at $6.55. In shingled assemblies, prices range as much as 7% lower. A 30% price reduction for 10% cells has lowered the cost from $8.25 to $5.65 in quantities of 100 to 999. 9% cells, previously priced at $4.65, are reduced to $3.95.

Suppliers

High Purity Metals has made available gold powder and sheet in purities of 99.999% for use as a matrix element in alloys for making joints to silicon. The electro-neutral material is available in lots from ½ troy ounces, with the powder 100 mesh or finer and the sheet in 4 inch maximum widths from thicknesses to .0005 inch.

Diotron Inc., Philadelphia has started to market N and P type single crystal gallium arsenide. Production is approximately 2,000 grams per month with its price at about $30 a gram in 100 gram lots.

Societe de la Vilille-Montagne, Belgium has made available germanium dioxide with density of 1.9. This is made available by Harmon, Lichtenstein and Co. of New York at $167.50 per kilo in minimum lots of 21 kilos.

Western Transistor Corporation of Gardena, California, which recently entered the field of transistor manufacturing, is making quantity shipment of their 2N327A series at prices ranging from $6.00 for the 2N327A, $13.00 for 2N328A and $20.00 for 2N329A.

General Thermoelectric Corp., Princeton, N.J., a joint subsidiary of General Devices, Inc. and Needco Cooling Semiconductors, Ltd., Montreal, has been formed for the purpose of marketing thermoelectric products in the United States. The new company will market, in particular, a line of thermocouples made of Neelium, a new semiconductor material that can produce heat or cold without moving parts.

Art Wire and Stamping Co., Newark, N.J., with the addition of new and improved wire straightening equipment has greatly increased capacity to produce finer quality, competitively-priced wire straights. This will enable the firm to speed up delivery of unusually straight wires with no surface markings, and with square-cut ends. The firm will regularly stock standard sizes of Rodar and 52 alloy wire for hermetic sealing purposes.

Financial

General Instrument Corp. of Newark, N.J. and General Transistor Corp. of New York have agreed to merge. Contemplated, is the issuance of seven-tenths of a share of GI common stock for each outstanding share of GT common. Sales for the nine month period ending Nov. 30, 1959 were reported as $41,277,875 for GI and $10,278,585 for GT.

Philco Corporation has declared the regular quarterly dividend of 93¾¢ per share on the company's Preferred Stock, payable July 1, 1960 to stockholders of record June 15, 1960.

APPLICATIONS

[from page 34]

level used. The *RC* combination in the emitter adjusts the conduction angle, and is chosen to limit the dissipation to an appropriate value.

Constructive Suggestions

Transfromers can be wound in many ways: air core, magnetic cores, (such as Q3 made by General Ceramics), etc., but a convenient and rapid way is simply to use #20 enameled wire and wrap turns on a ½" diameter form; magnetic cores are somewhat difficult to wind by comparison. The calculated turns ratios can usually be somewhat improved by trial and error, but the calculated ratios are normally very close.

It is of course essential to be very careful with the wiring. It is helpful to use a thin copper base plate to act as ground, and solder all ground points to this plate. All components should of course be suitable for use in the *vhf* region, particularly the capacitors. It is necessary to use heat sinks. Jadaro 1101A units are particularly well suited, as explained in Fairchild Application Note #6. A single 4" x 4" plate can be used for both output transistors, since the collectors are tied together. Forced air cooling is helpful. The heat sinks add about 20 μμf output capacitance if the cooling plates are grounded.

[Circle 200 on Reader Service Card]

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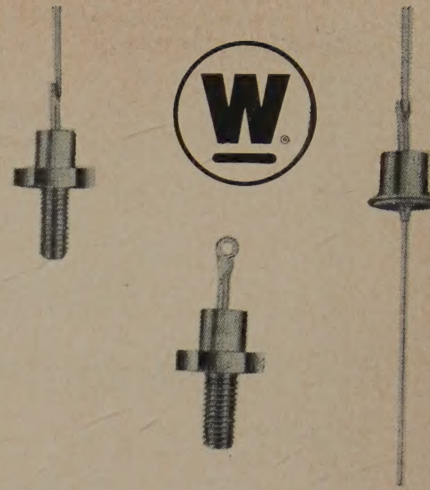

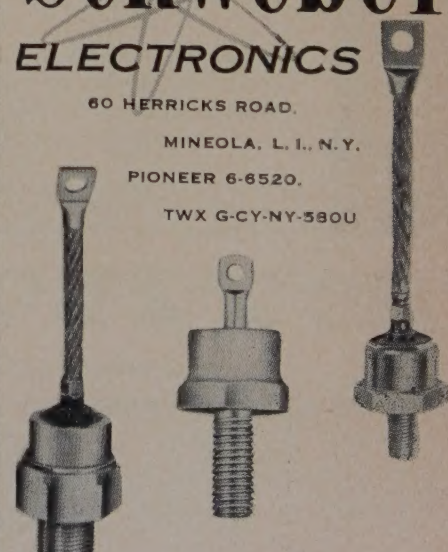

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